Optics

(Lec-3)

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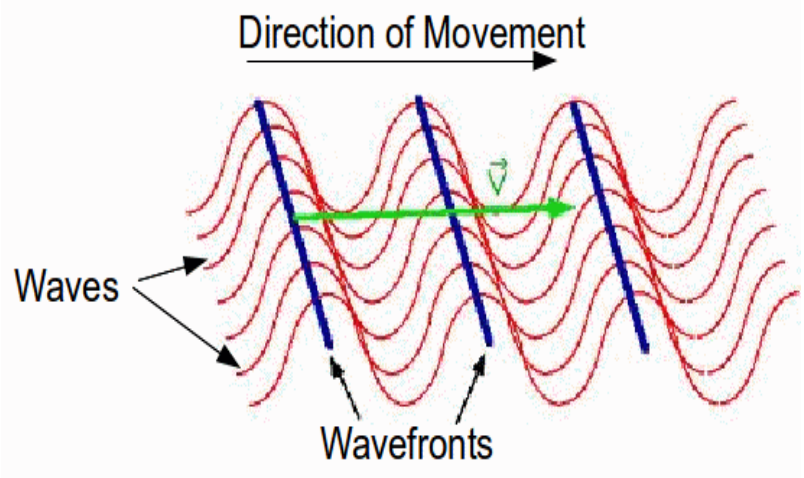
OUTLINES

- Wavefront
- Huygens's principle
- Superposition principle

Wavefront

A wavefront is a surface over which an optical wave has a constant phase. For example, a wavefront could be the surface over which the wave has a maximum (the crest of a water wave, for example) or a minimum (the trough of the same wave) value.

The shape of a wavefront is usually determined by the geometry of the source. A point source has wavefronts that are spheres whose centers are at the point source. A fluorescent tube would have wavefronts that are cylinders concentric with the tube itself. A very large sheet of material that is uniformly illuminated would generate wavefronts that are plane waves parallel to the sheet.



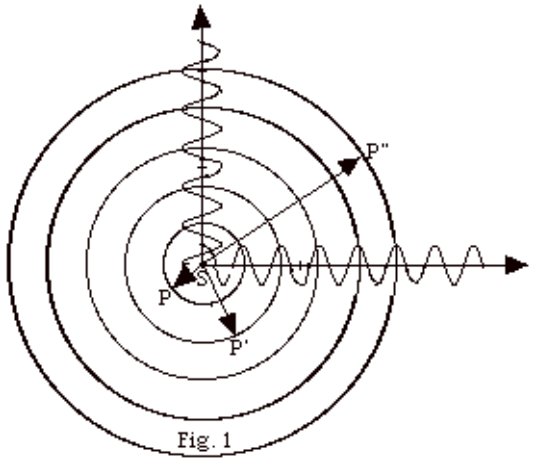


Fig. 1

Huygens's Principle

Sir Isaac Newton proposed that light was made of tiny particles known as the photons while Christian Huygens believed that light was made of waves propagating perpendicular to the direction of its movement.

In 1678, Huygens proposed that *"Every point on a wave-front may be considered a source of secondary spherical wavelets which spread out in the forward direction at the speed of light. The new wave-front is the tangential surface to all of these secondary wavelets". This theory of light is known as the 'Huygens' Principle'.*

Using the above-stated principle, Huygens was successful in deriving the laws of reflection and refraction of light. He was also successful in explaining the linear and spherical propagation of light using this theory. However, he wasn't able to explain the diffraction effects of light. Later, in 1803, the experiment conducted by Thomas Young on the interference of light proved the Huygens wave theory of light to be correct. Later in 1815, Fresnel provided mathematical equations for Young's experiment.

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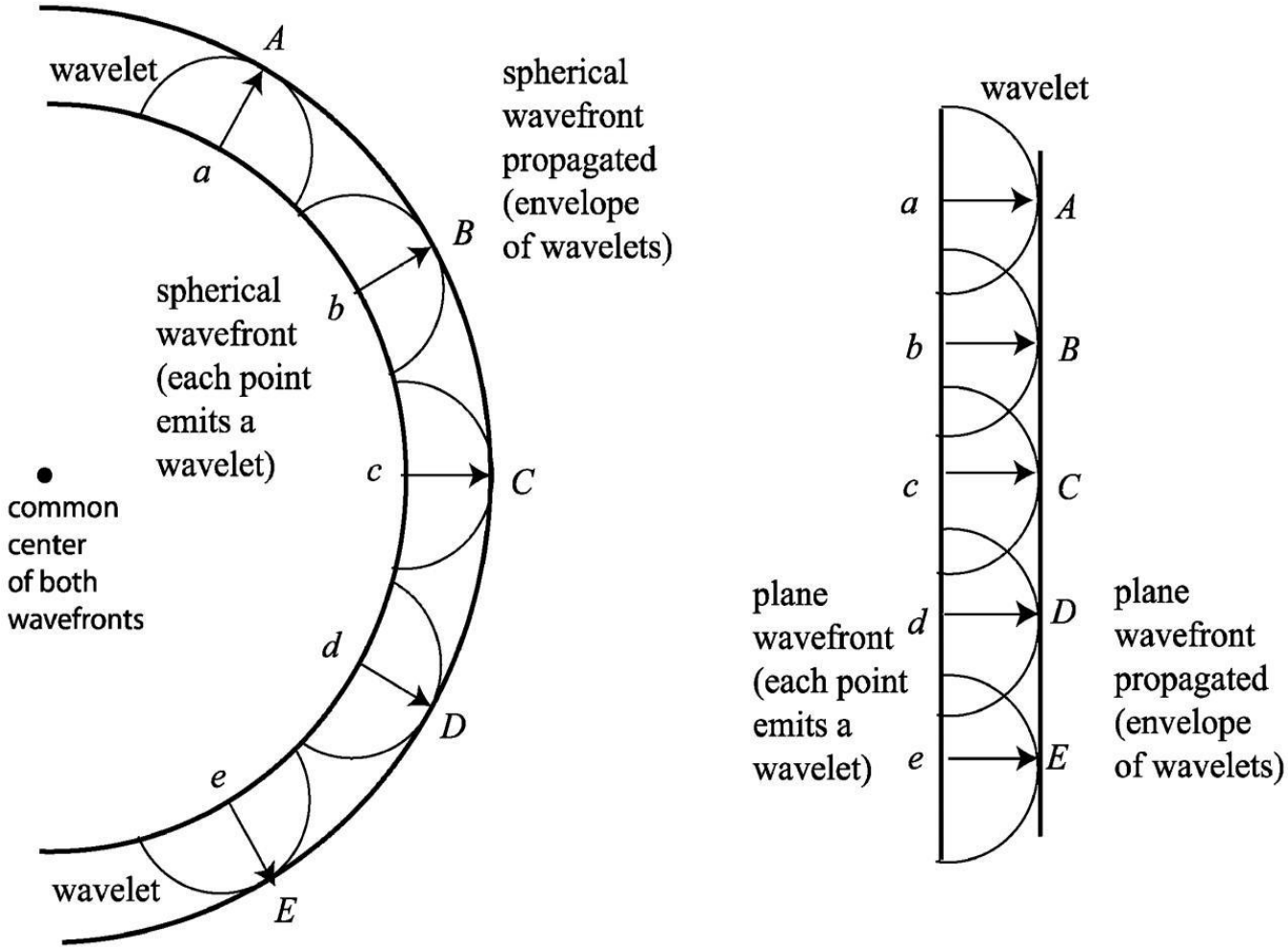

wavelet
A
a
B
b
C
c
D
d
e
E
wavelet
spherical wavefront propagated (envelope of wavelets)
spherical wavefront (each point emits a wavelet)
common center of both wavefronts
wavelet
plane wavefront (each point emits a wavelet)
plane wavefront propagated (envelope of wavelets)

Fig. 1

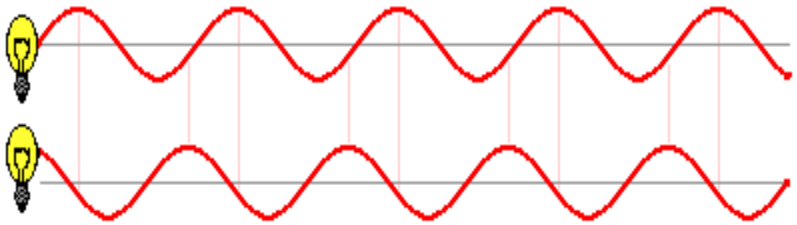
Conditions of Interference

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

1. The sources of the waves must be coherent, which means they emit identical waves with a constant phase difference.
2. The waves should be monochromatic - they should be of a single wavelength.

Coherent Sources

Those sources of light which emit light waves continuously of same wavelength, time period, frequency, and amplitude and have zero phase difference or constant phase difference are called coherent sources.

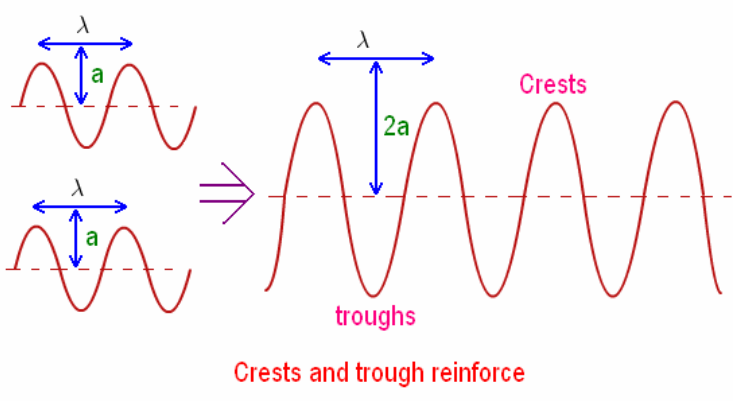


These two waves are coherent - they have a phase difference which is constant over time.

There are two types of interference.
Constructive Interference.
Destructive Interference.

Constructive Interference

When two light waves superpose with each other in such a way that the crest of one wave falls on the crest of the second wave, and trough of one wave falls on the trough of the second wave, then the resultant wave has larger amplitude and it is called constructive interference.



Destructive Interference

When two light waves superpose with each other in such a way that the crest of one wave coincides the trough of the second wave, then the amplitude of resultant wave becomes zero and it is called destructive interference.

