

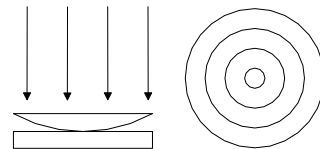
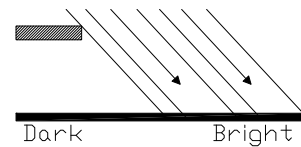
# APPLIED OPTICS

## Lecture-1 LIGHT: CONCEPT and APPLICATIONS

### 1.1A What is light? Is it a wave? Is it a stream of particles?

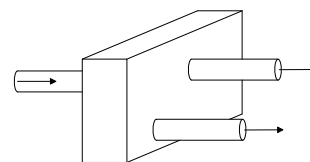
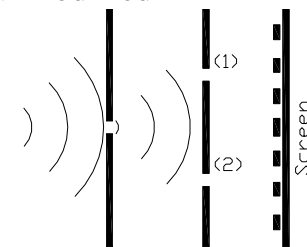
#### • Light as a particle

- NEWTON (1642 – 1727) was the most prominent advocate of this theory
- Ray of light conceptualized as a stream of very small particles emitted from a source of light and traveling in straight lines
- This view was based on the fact that light can cast sharp shadows
- But can not explain well what is now known as Newton's rings



#### • Light as a WAVE

- CHRISTIAN HUYGENS (1629 – 1695) contemporary of Newton, championed this view
  - ✧ When two beams of light intersect they emerge unmodified
- 1801 YOUNG's Double-Slit experiment
  - ✧ The complex shadows formed by the two slits (in the form of an interference pattern) seem to demand a wave interpretation.
- 1821 FRESNEL
  - ✧ Light is a transverse wave
  - ✧ Light is polarized
  - ✧ Explained the phenomenon of double refraction in calcite



- Independent of this progress in optics, the study of electricity and magnetism was also flourishing

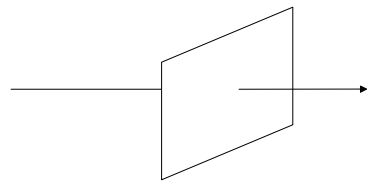
➤ JAMES C. MAXWELL (1831-1839) is a genius who condensed the phenomena of electromagnetism into a set of four equations

✧ Predicts EM-waves travel at speed =  $\frac{1}{\sqrt{\epsilon_0 \mu_0}}$

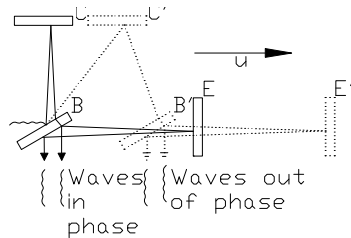
✧ It turns out  $\frac{1}{\sqrt{\epsilon_0 \mu_0}} = 300,000 \frac{km}{S}$  !!

Light must be an electromagnetic wave !

➤ 1887 HEINRICH HERTZ confirms experimentally the existence of electromagnetic waves



➤ 1887 A. MICHELSON and E. MORLEY if the speed of light is constant in the aether and the earth presumably moves in relation to the aether (at ~67,000 mi/h) then the speed of light with respect to the earth should be affected by the planet's motion. BUT no motion of the earth with respect to the aether was detected.



➤ A. EINSTEIN, special theory of relativity

- ✧ Rejected the aether hypothesis
- ✧ Light always propagates with a definite velocity  $c$  (in empty space) which is independent of the motion of the light source

Light was then envisaged as a self-sustained electromagnetic wave

The 19<sup>th</sup> century: served to place the wave theory of light on a firm foundation.

However,

by the end of 19<sup>th</sup> century - beginning of 20<sup>th</sup> century:

It became evident that the wave theory of light could not explain certain experiments (the blackbody radiation, for example.) Indeed, the wave theory of

light began to crumble, as we describe in the next section.