

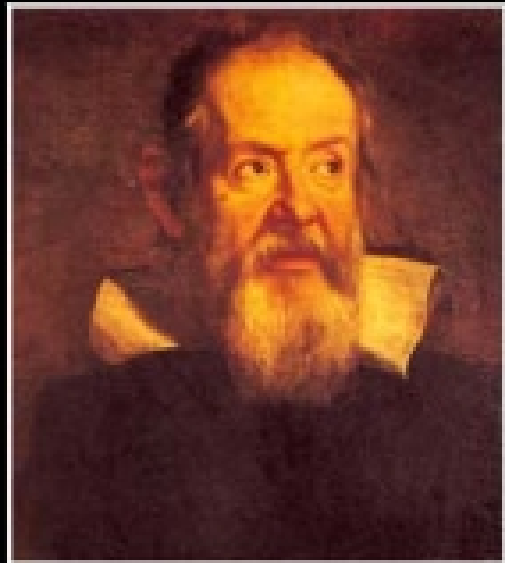


Guiding Questions

1. How fast does light travel? How can this speed be measured?
2. Why do we think light is a wave? What kind of wave is it?
3. How is the light from an ordinary light bulb different from the light emitted by a neon sign?
4. How can astronomers measure the temperatures of the Sun and stars?
5. What is a photon? How does an understanding of photons help explain why ultraviolet light causes sunburns?
6. How can astronomers tell what distant celestial objects are made of?
7. What are atoms made of?
8. How does the structure of atoms explain what kind of light those atoms can emit or absorb?
9. How can we tell if a star is approaching us or receding from us?

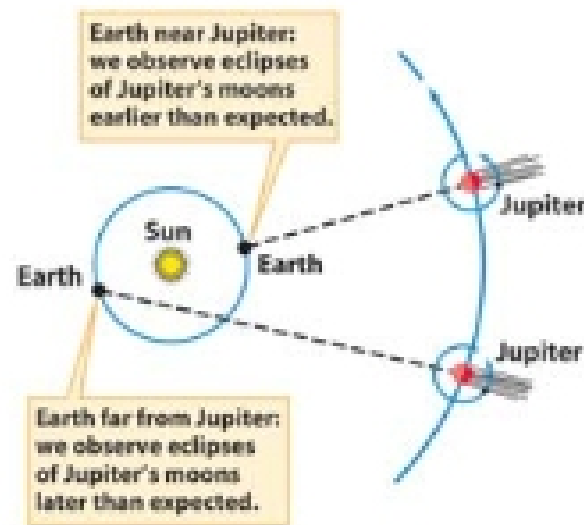
Determining the Speed of Light

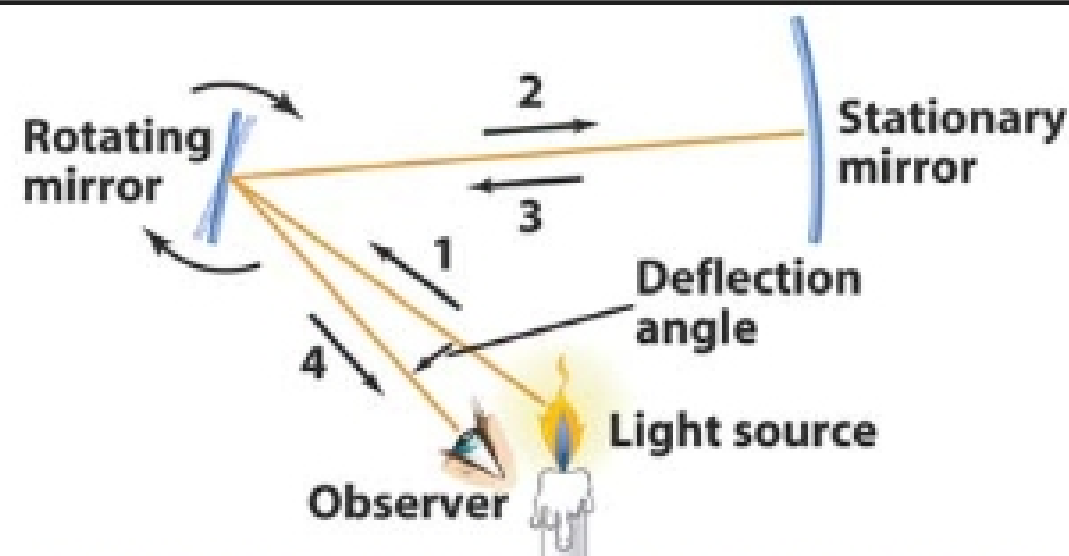
- Galileo tried unsuccessfully to determine the speed of light using an assistant with a lantern on a distant hilltop



Light travels through empty space at a speed of 300,000 km/s

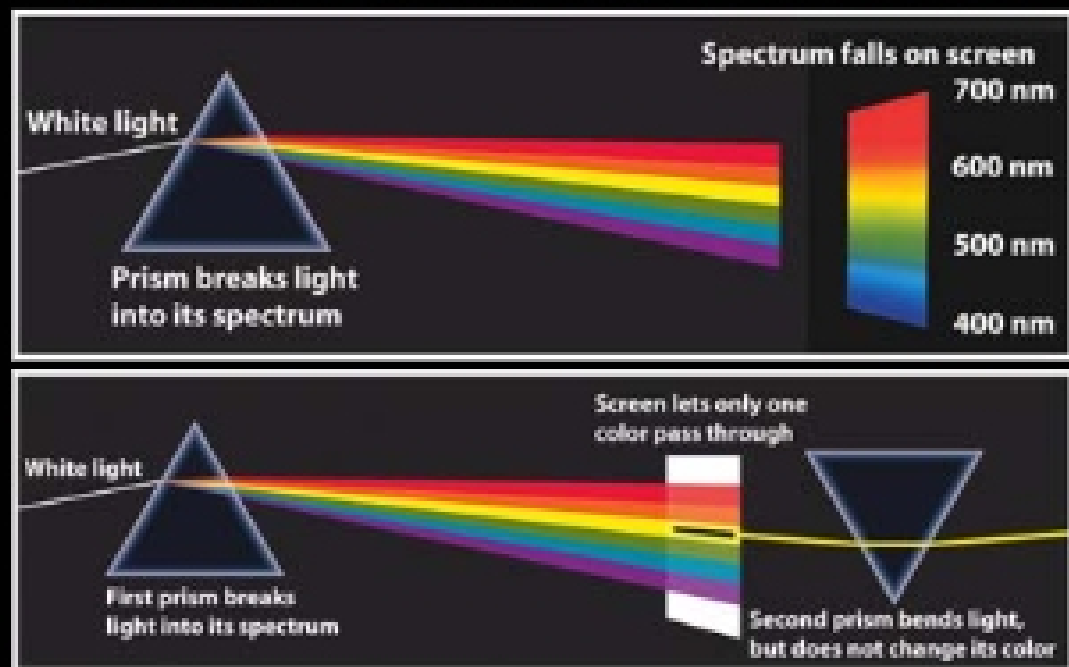
- In 1676, Danish astronomer Claus Rømer discovered that the exact time of eclipses of Jupiter's moons depended on the distance of Jupiter to Earth
- This happens because it takes varying times for light to travel the varying distance between Earth and Jupiter
- Using $d=rt$ with a known distance and a measured time gave the speed (rate) of the light





- In 1850 Fizeau and Foucault also experimented with light by bouncing it off a rotating mirror and measuring time
- The light returned to its source at a slightly different position because the mirror has moved during the time light was traveling
- $d=rt$ again gave c

Light is electromagnetic radiation and is characterized by its wavelength (λ)



Wavelength and Frequency

Frequency and wavelength of an electromagnetic wave

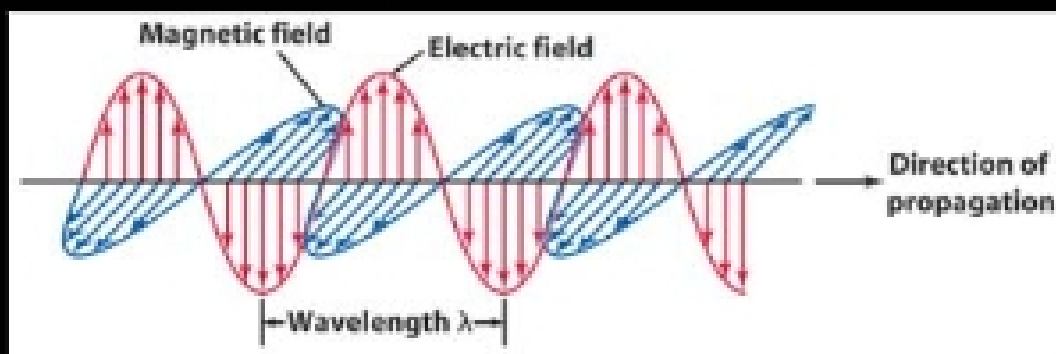
$$v = \frac{c}{\lambda}$$

v = frequency of an electromagnetic wave (in Hz)

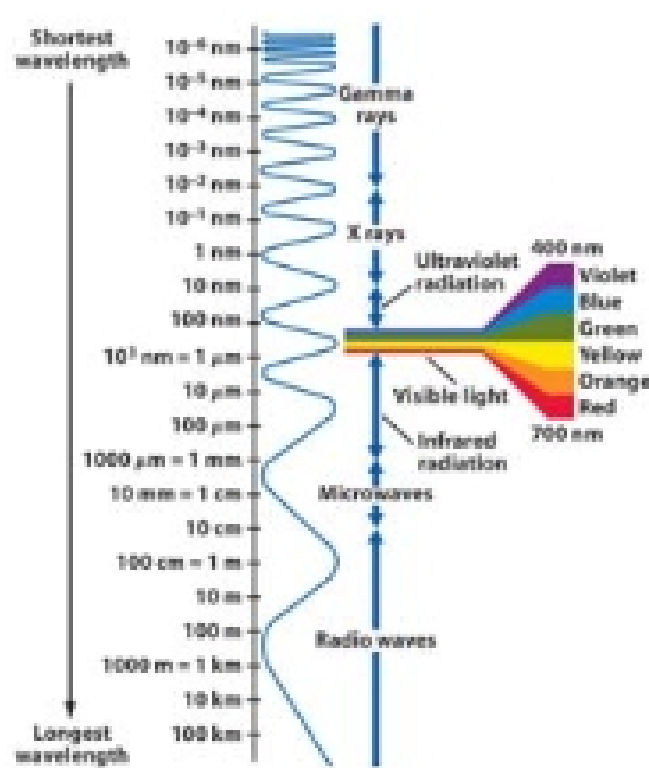
c = speed of light = 3×10^8 m/s

λ = wavelength of the wave (in meters)

The Nature of Light



- In the 1860s, the Scottish mathematician and physicist James Clerk Maxwell succeeded in describing all the basic properties of electricity and magnetism in four equations
- This mathematical achievement demonstrated that electric and magnetic forces are really two aspects of the same phenomenon, which we now call electromagnetism



- Because of its electric and magnetic properties, light is also called electromagnetic radiation
- Visible light falls in the 400 to 700 nm range
- Stars, galaxies and other objects emit light in all wavelengths
