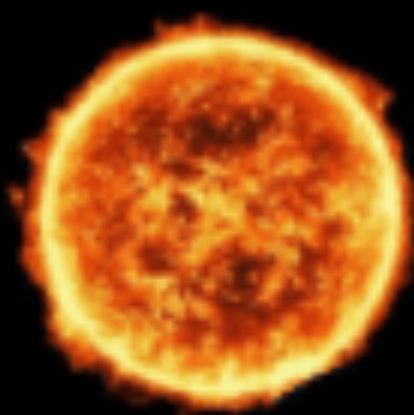


**Lunar  
Eclipse**



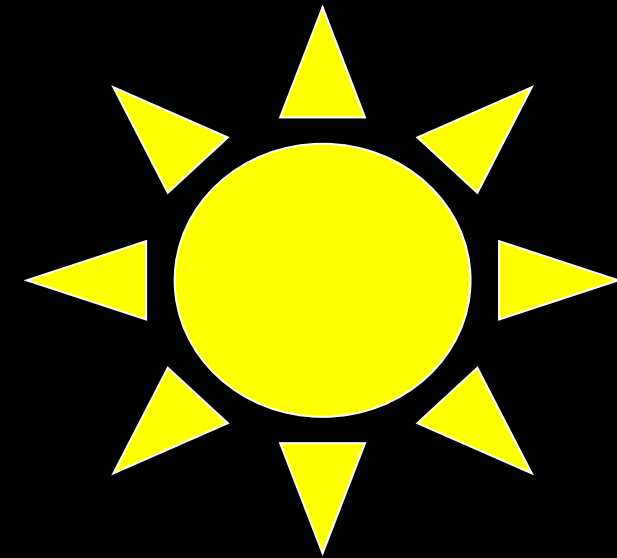
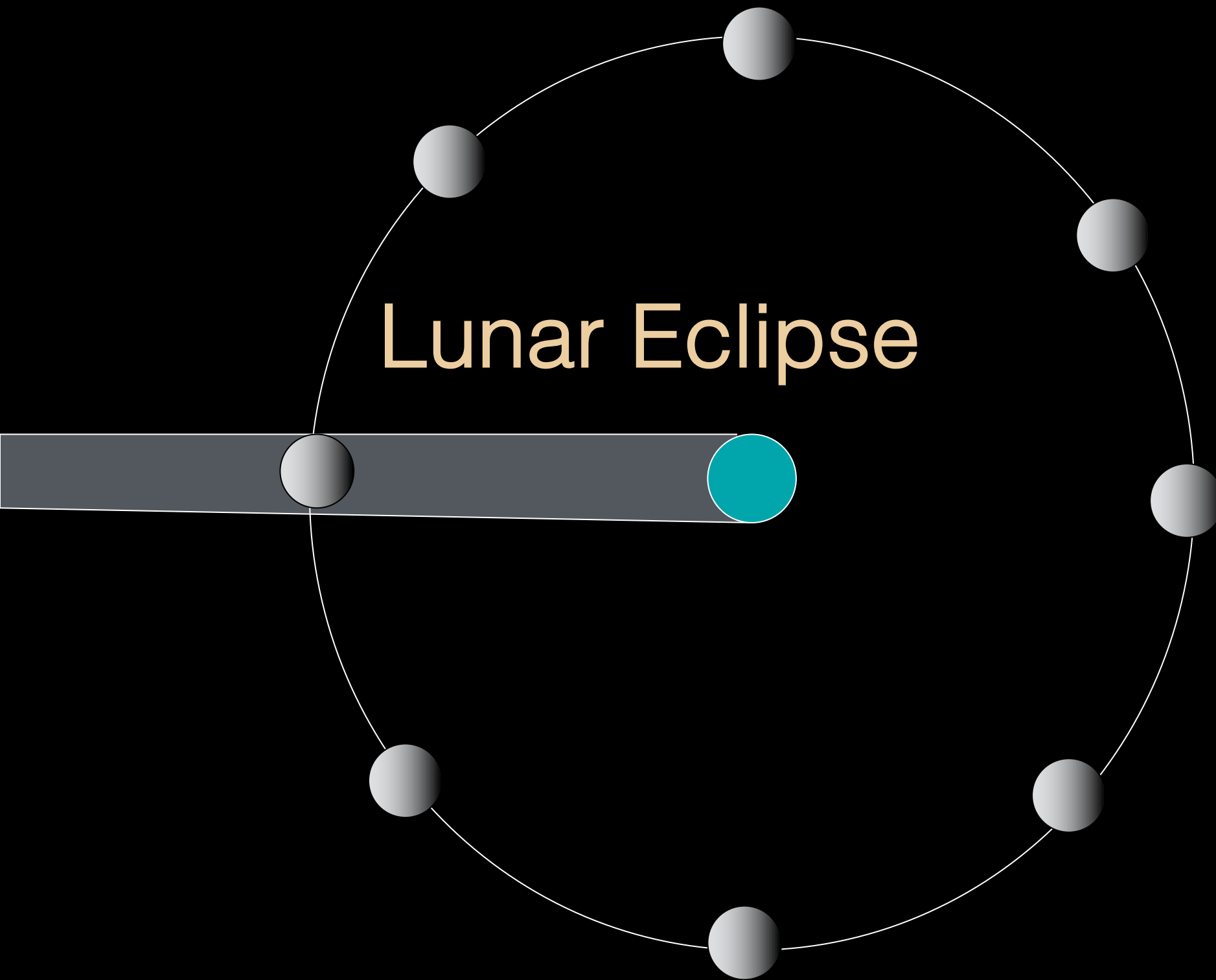
**Solar  
Eclipse**



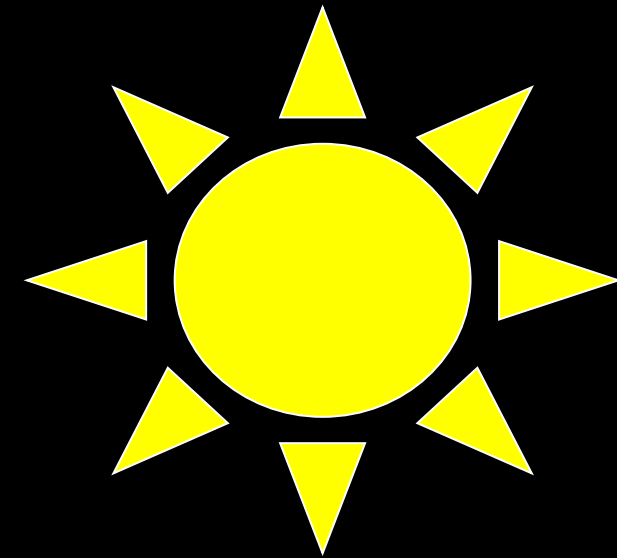
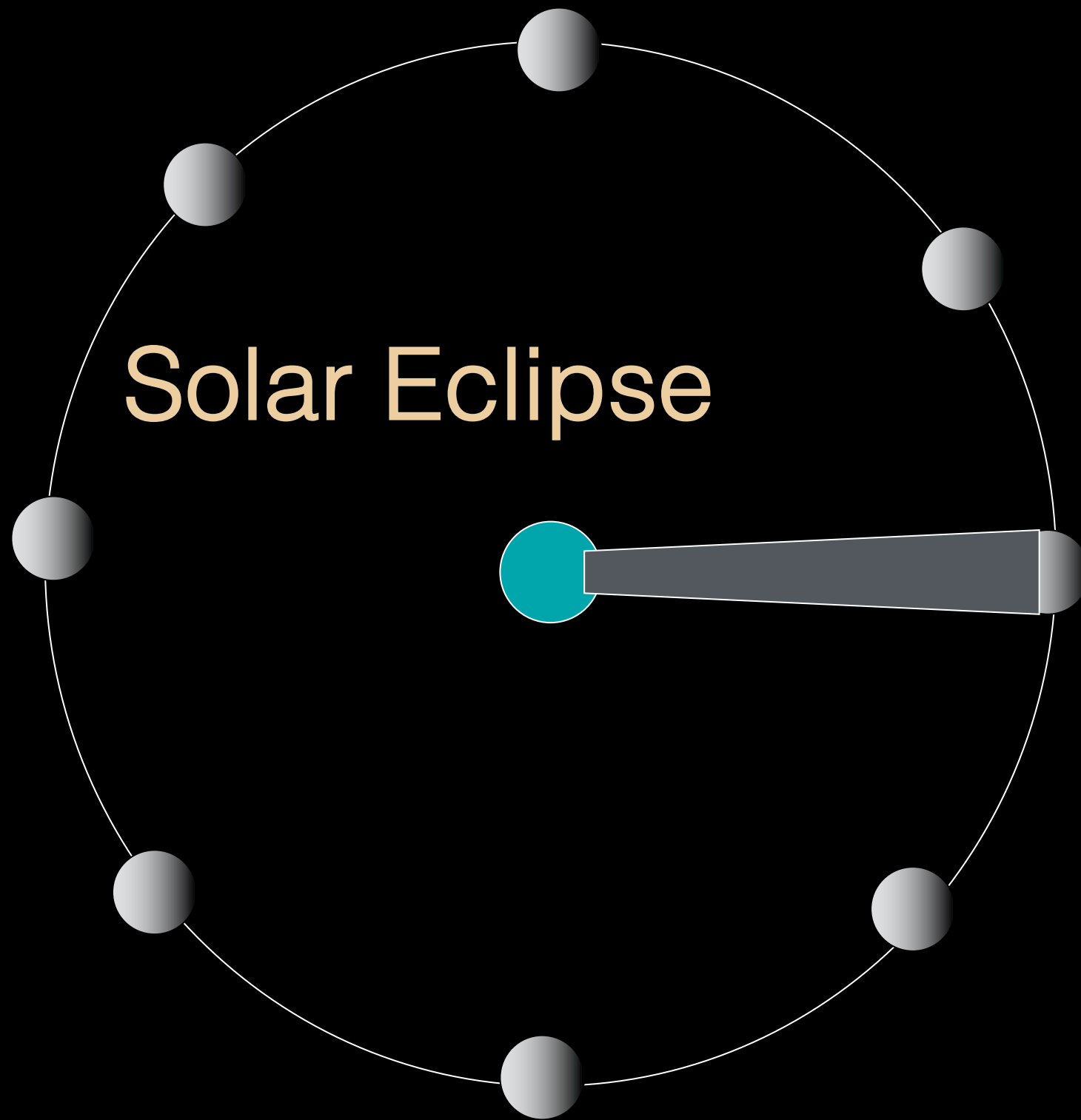
**Apocalypse**



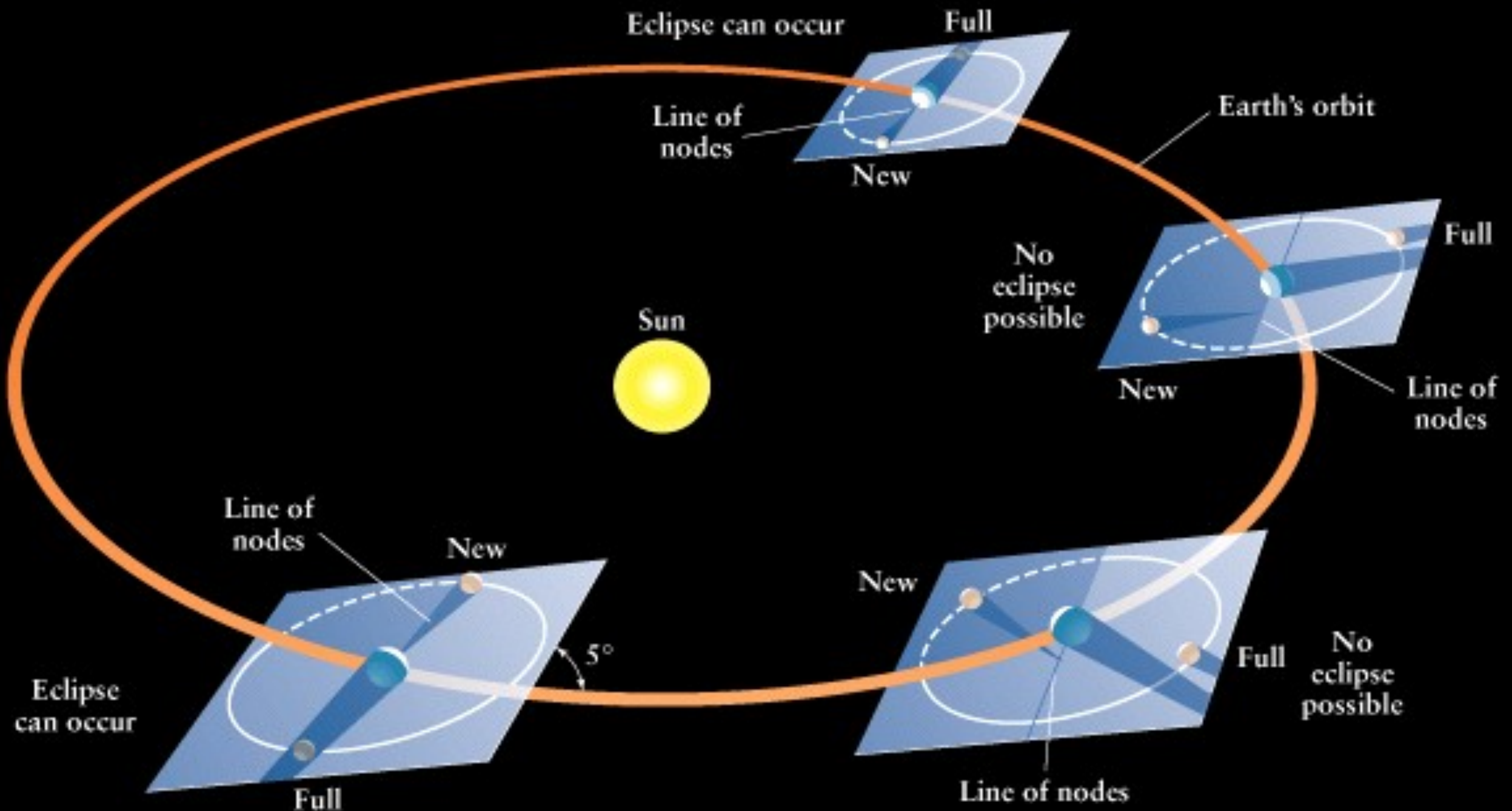
When the Earth's shadow hits the Moon we have a...



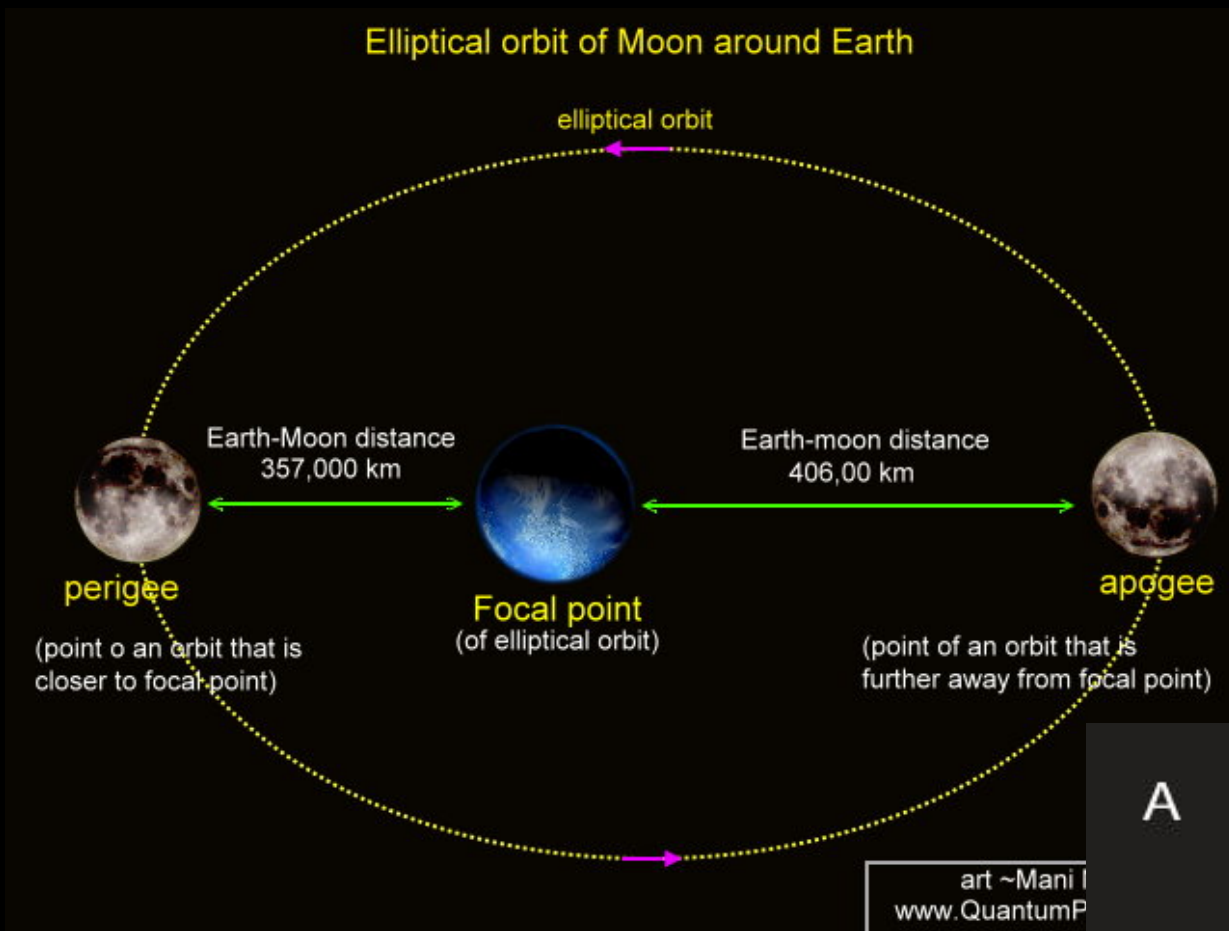
When the Moon's shadow hits the Earth, we have a ....



Eclipses occur **ONLY** when the Moon crosses the plane of Earth's orbit around the Sun **AND ONLY** during the **NEW** or **FULL** phases

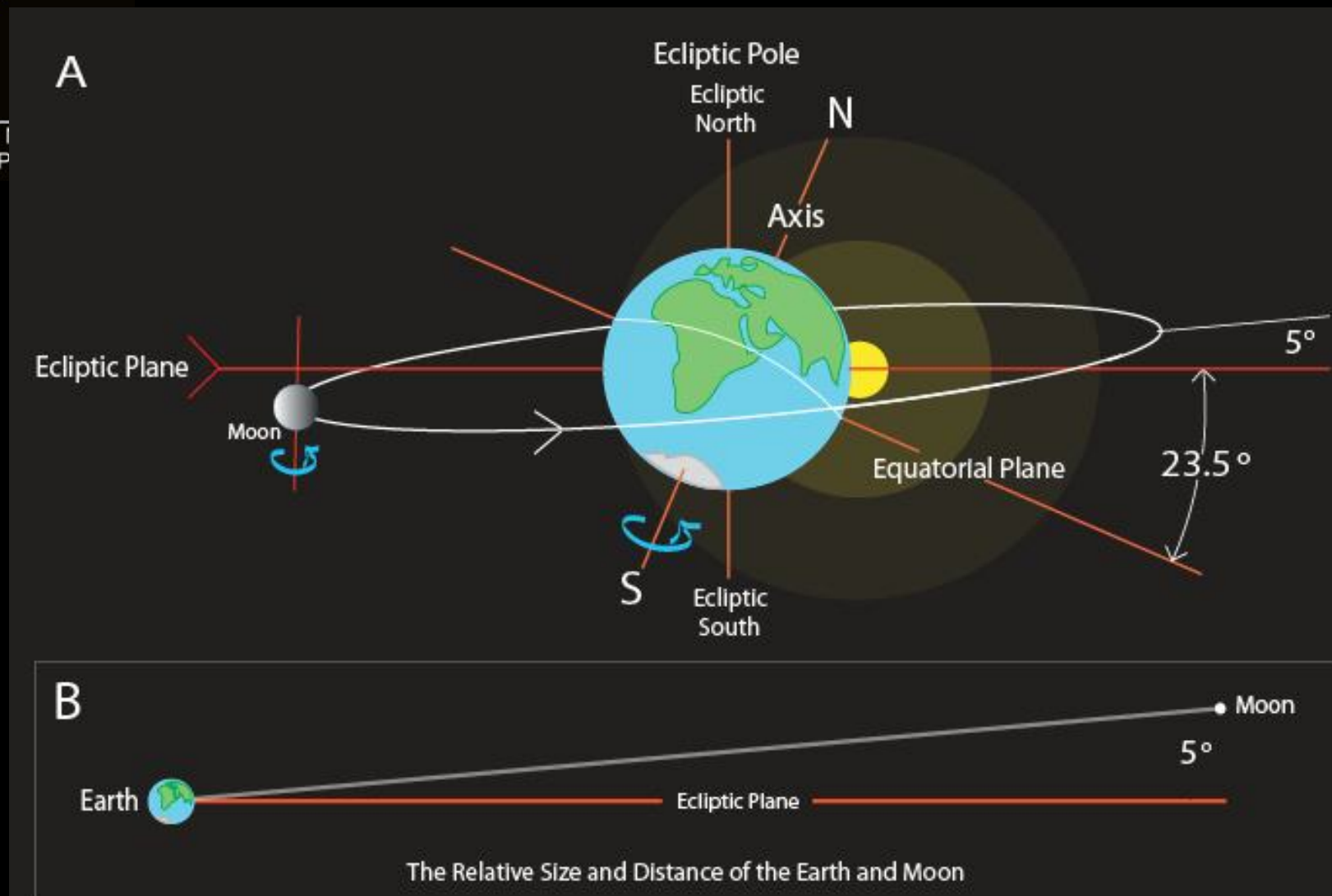


# Two Important Properties of the Moon's Orbit



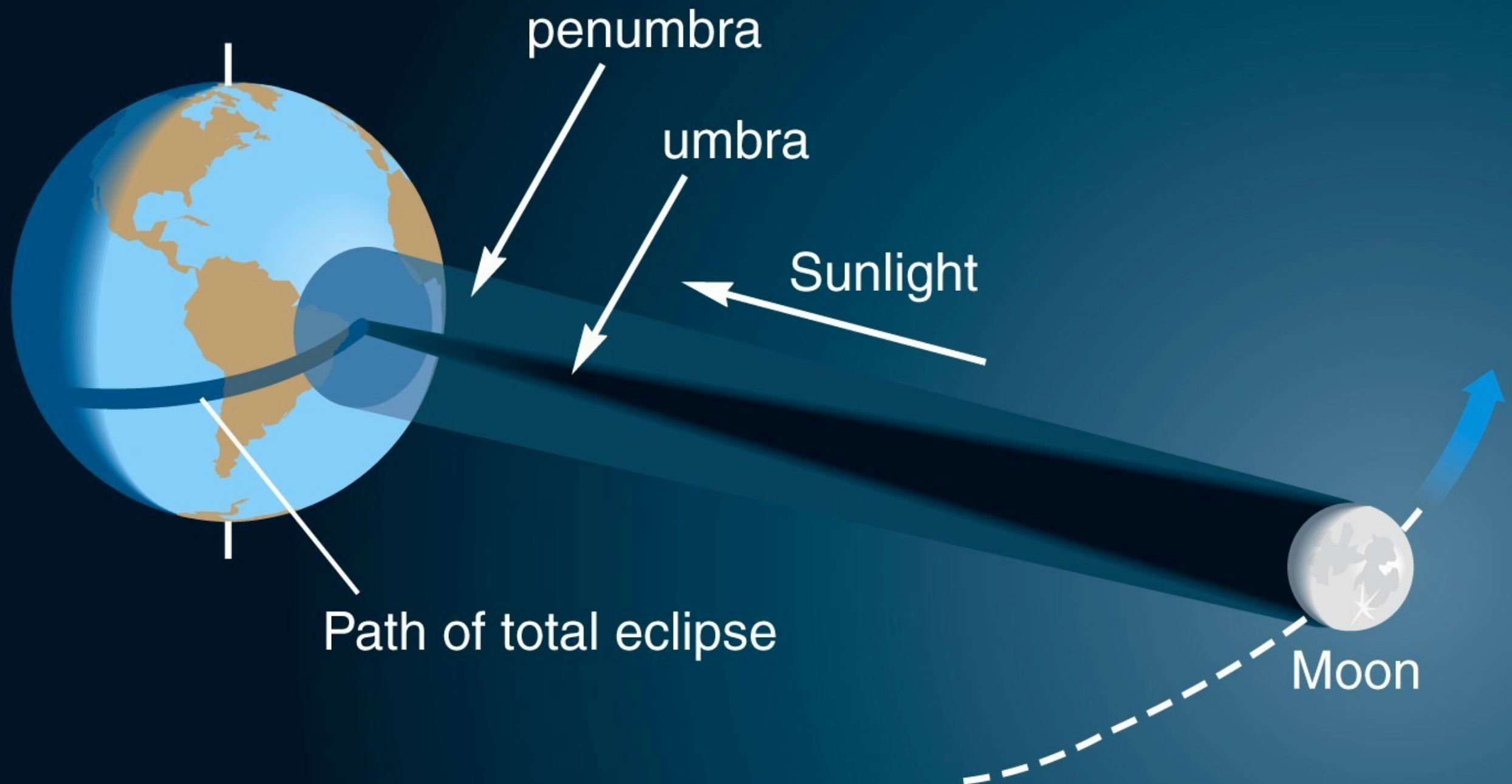
<- Its an ellipse

It's tilted 5 degrees with respect to the ecliptic plane ->





**Solar eclipse** - when the moon passes in front of the Sun as seen from the Earth



They are spectacular  
but not common.

Next total eclipse  
visible from USA:  
April 8, 2024

Partial Solar Eclipse

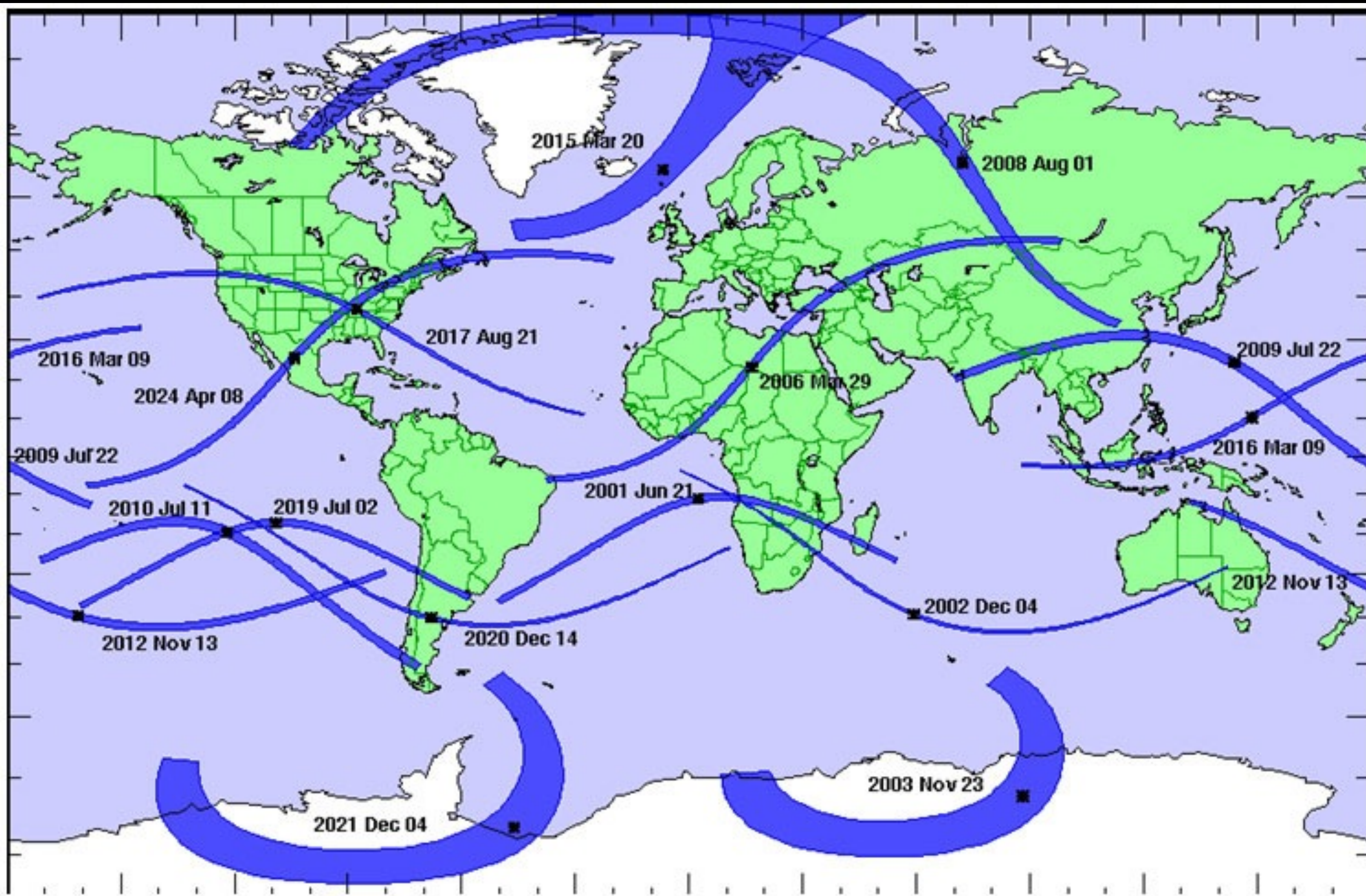


Annular Solar Eclipse





# Map of solar eclipses

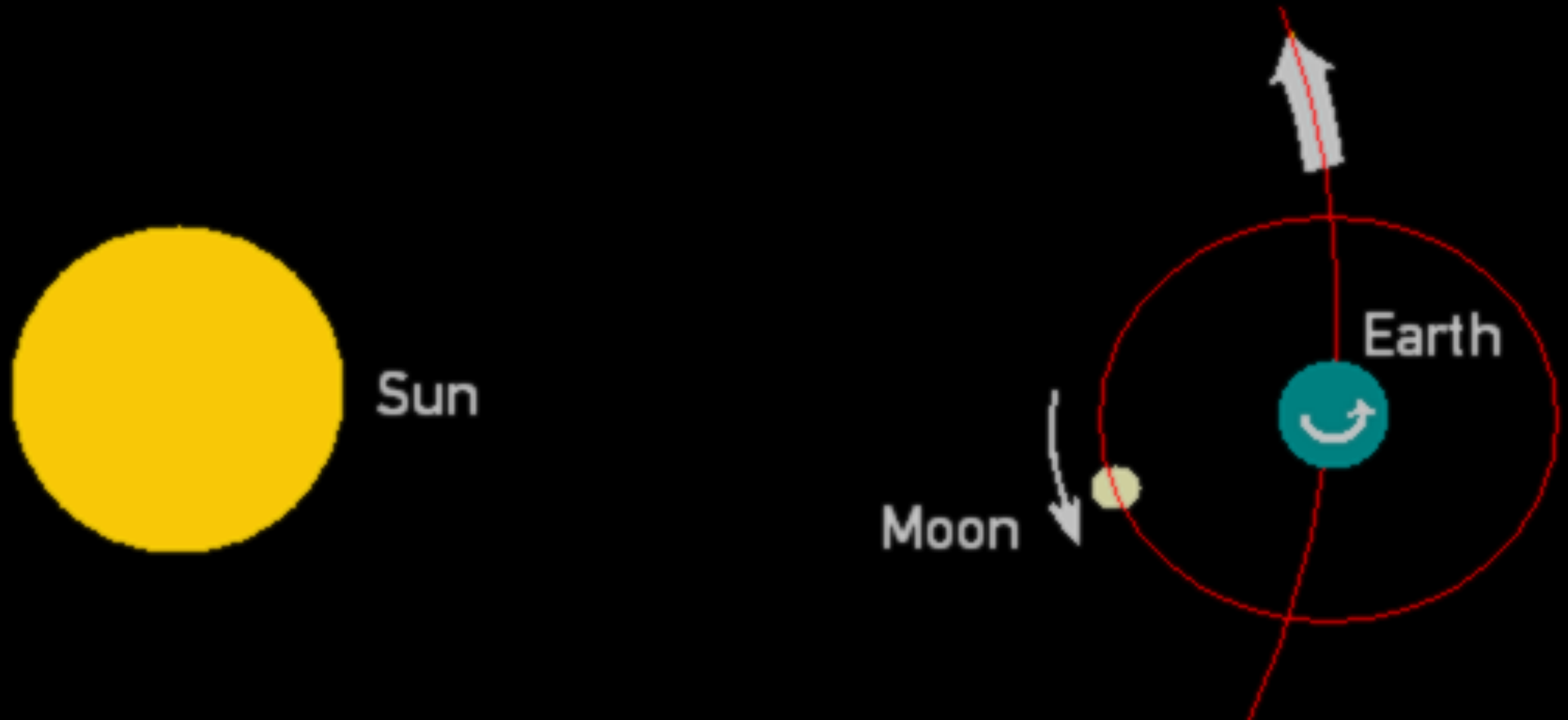




# Lunar eclipses are more common than solar eclipses - its geometry



The eclipse frequency is related to distances and sizes of Sun, Earth and Moon.



Now let's do a demo...



# Which positions cause which eclipses

- When the \_\_\_\_\_ is in the \_\_\_\_\_ phase and is directly in line with the \_\_\_\_\_ and the \_\_\_\_\_, you get a \_\_\_\_\_ eclipse.
- When the \_\_\_\_\_ is in the \_\_\_\_\_ phase and is directly in line with the \_\_\_\_\_ and the \_\_\_\_\_, you get a \_\_\_\_\_ eclipse.

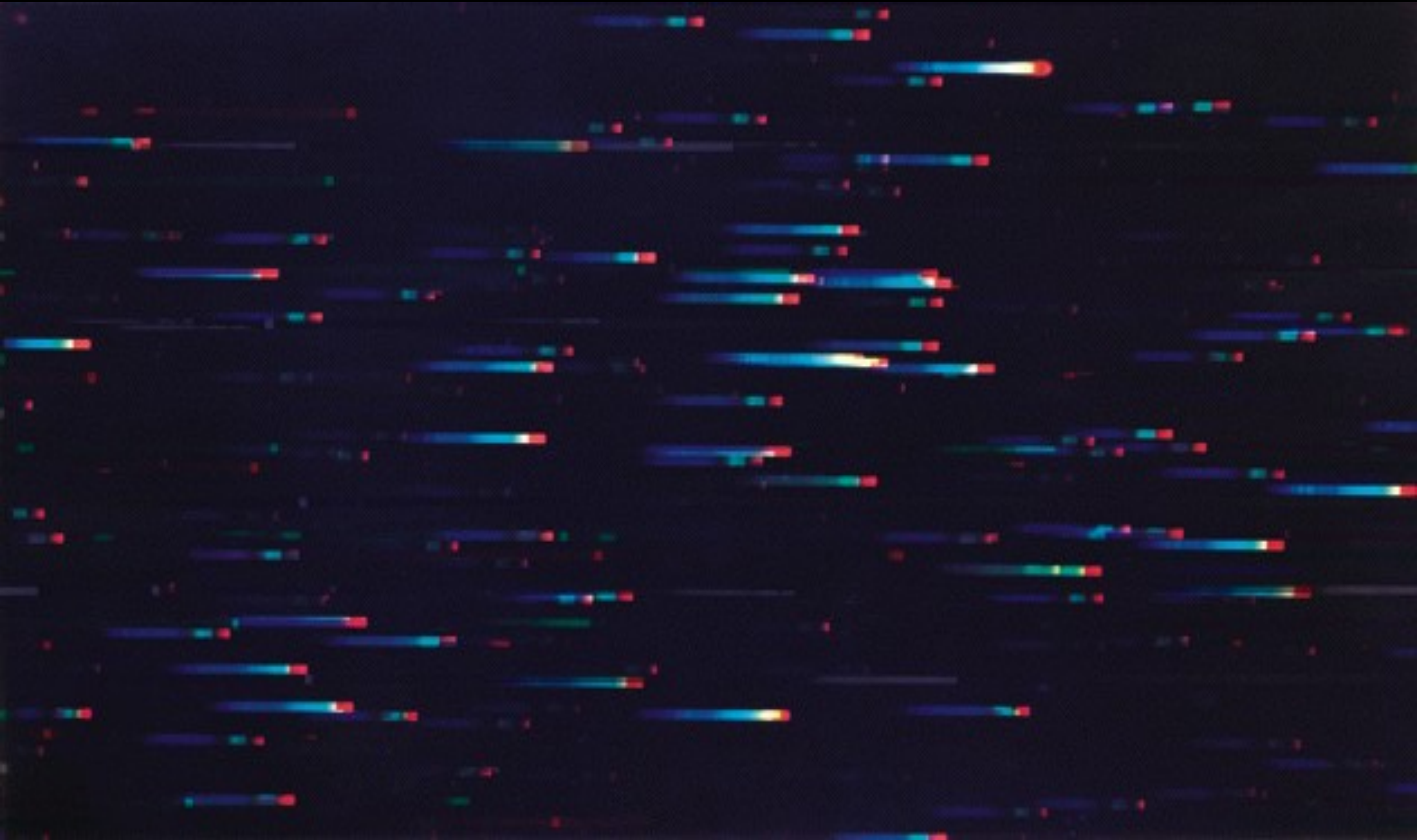
# Which positions cause which eclipses

- When the Moon is in the full phase and is directly in line with the Earth and the Sun , you get a lunar eclipse.
- When the Moon is in the new phase and is directly in line with the Earth and the Sun , you get a solar eclipse.





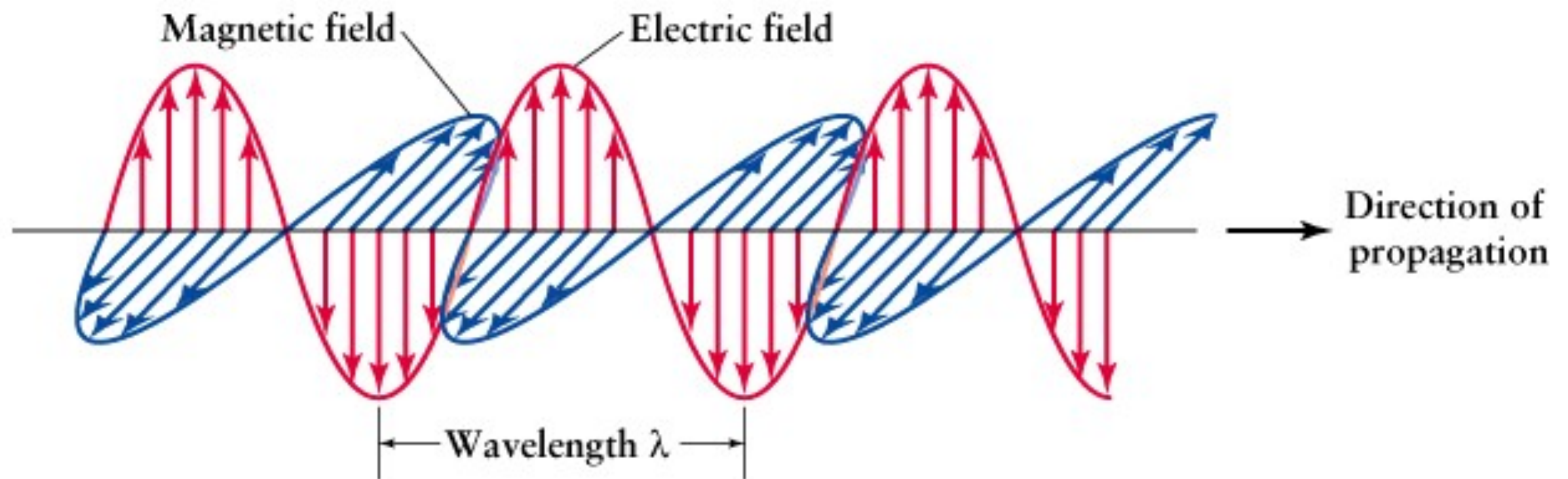
# The Origin and Nature of Light



# But, what is light?

- In the 17th Century, Isaac Newton argued that light was composed of little particles while Christian Huygens suggested that light travels in the form of waves.
- In the 19<sup>th</sup> and 20<sup>th</sup> Century Maxwell, Young, Einstein and others were able to show that light behaves both like a particle and a wave depending on how you observe it.

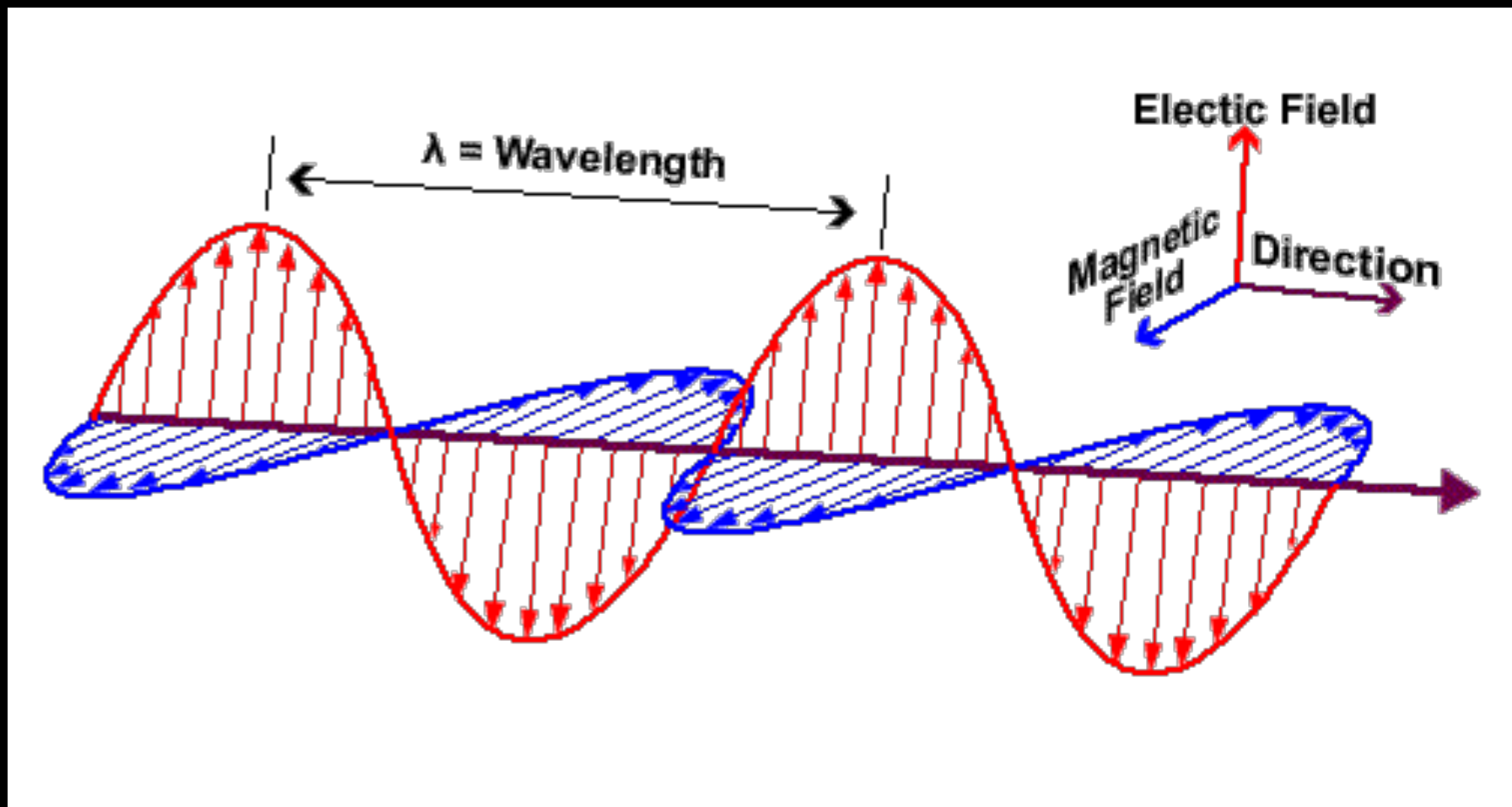
Scottish physicist James Clerk Maxwell showed mathematically in the 1860s that light must be a combination of electric and magnetic fields.





Light is produced by accelerating charges, and can travel through empty space - **electromagnetic radiation**

- Unlike sound, light waves do not require a medium and thus can travel through a vacuum.



- Electromagnetic radiation is a **wave** phenomenon.
- That is, it is associated with a periodically repeating disturbance (a wave) that carries energy.
- Imagine waves in water.
  - If you disturb a pool of water, waves spread across the surface.



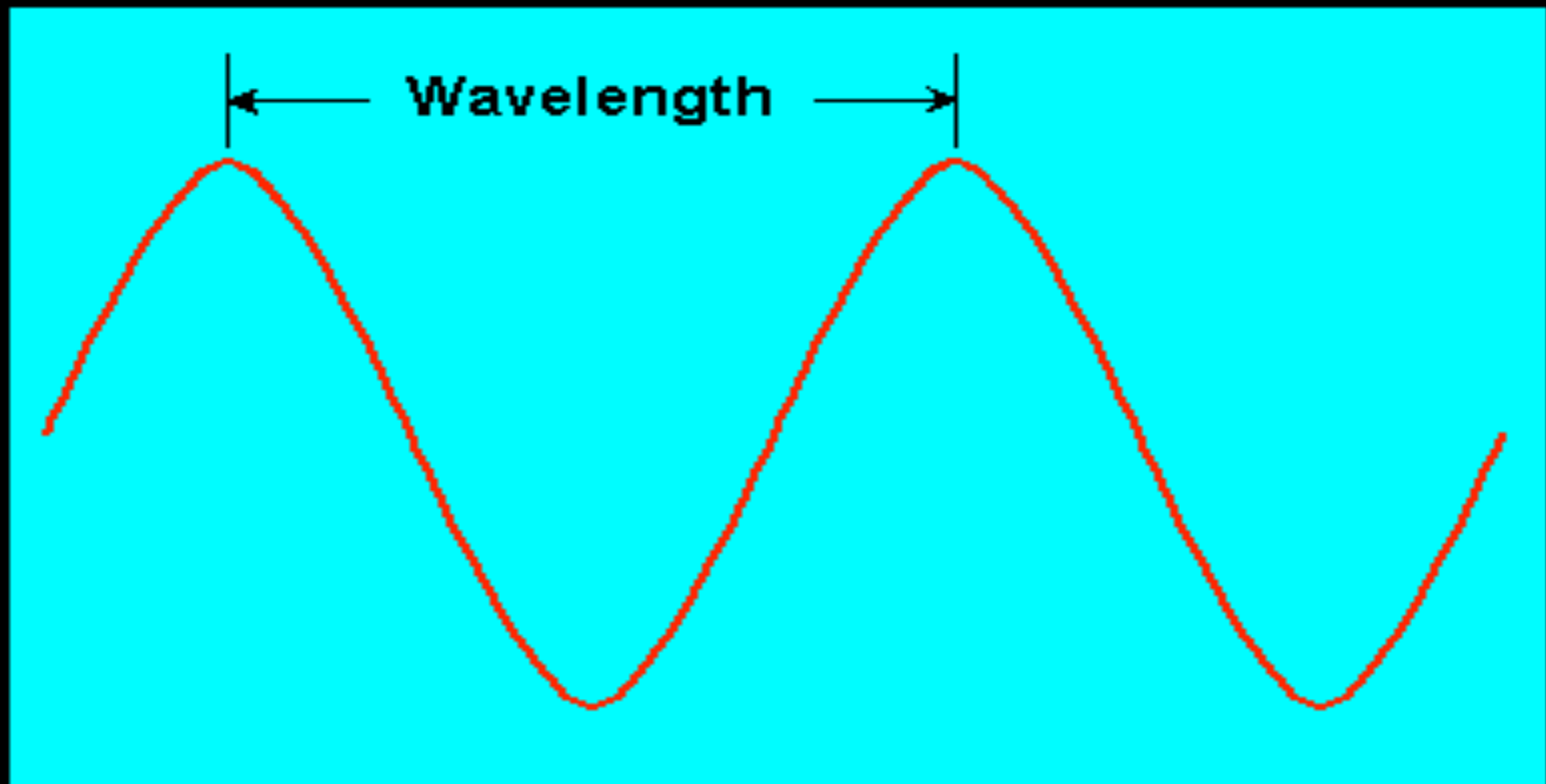
DO NOT confuse radioactivity with the term EM radiation!





The distance between peaks of a light wave is the **wavelength**

- Astronomers use nano-meters ( $10^{-9}$  m), Angstroms ( $10^{-10}$  m) or microns ( $10^{-6}$  m) as the unit of a wavelength of light

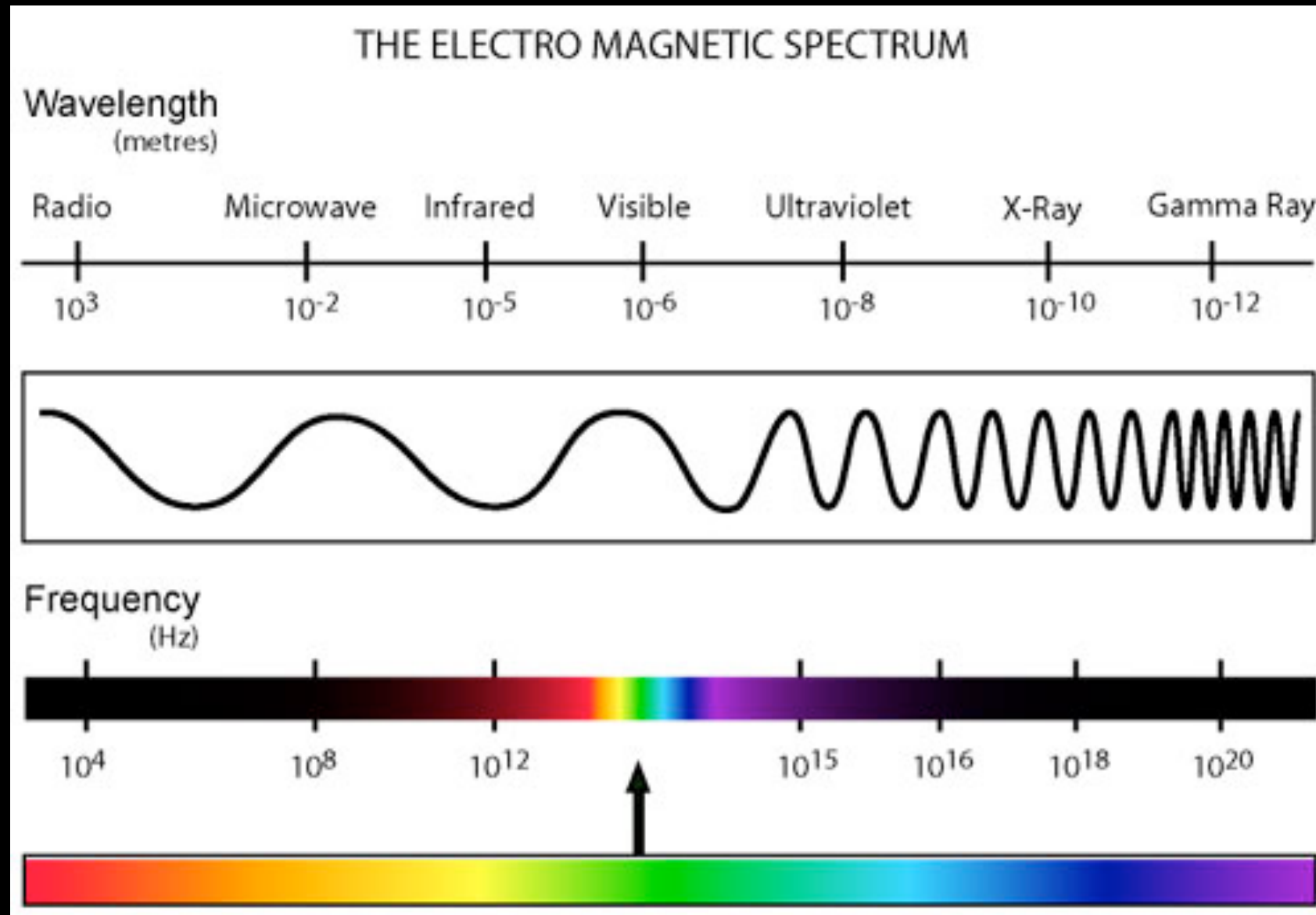


- Light waves travel through space at about 300,000 kilometers per second (186,000 miles per second).
- It is the speed of ALL electromagnetic radiation.



The number of repeating events per unit time = **frequency**

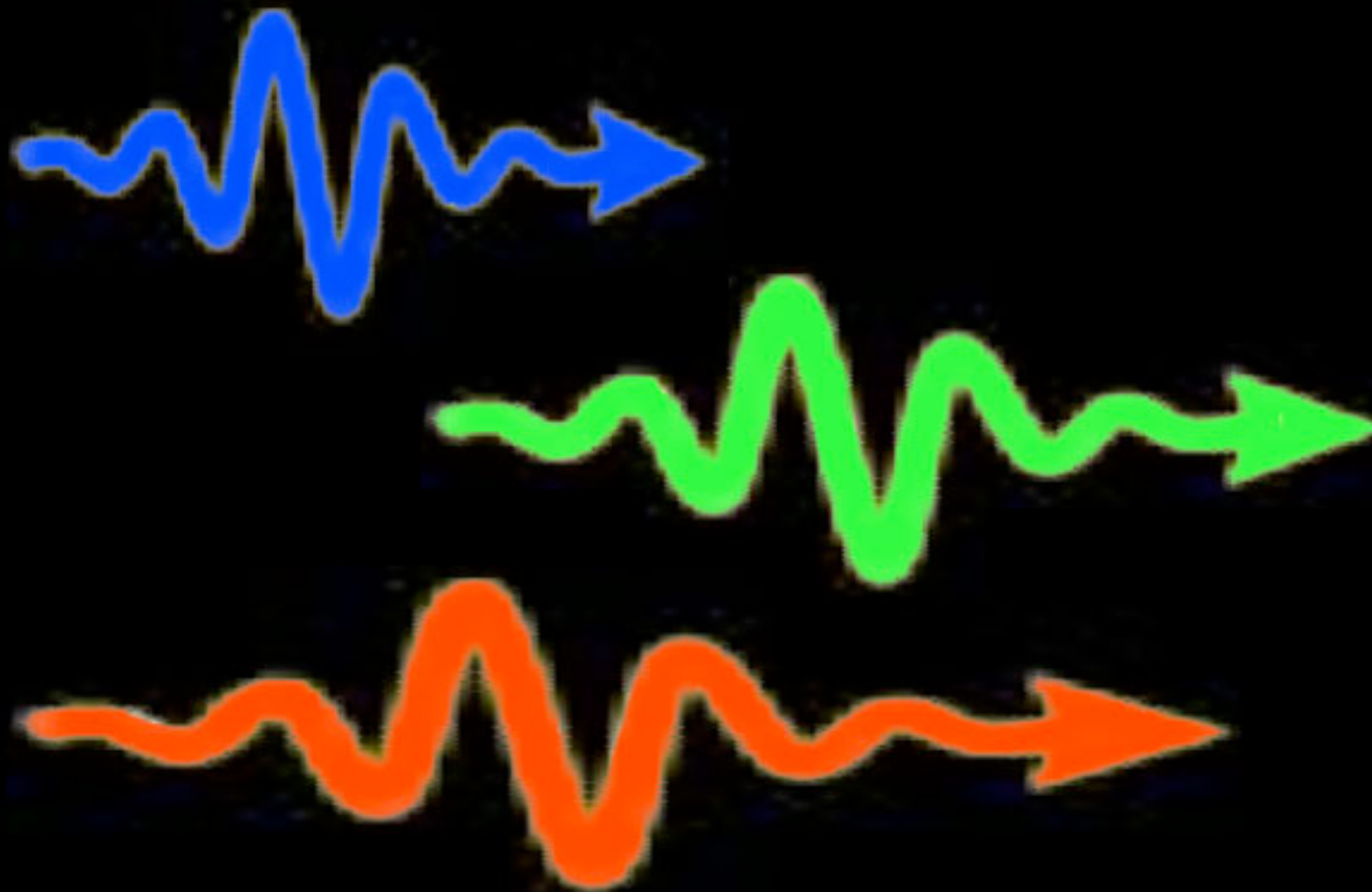
Unit = Hertz (Hz)



Longer the wavelength, smaller the frequency

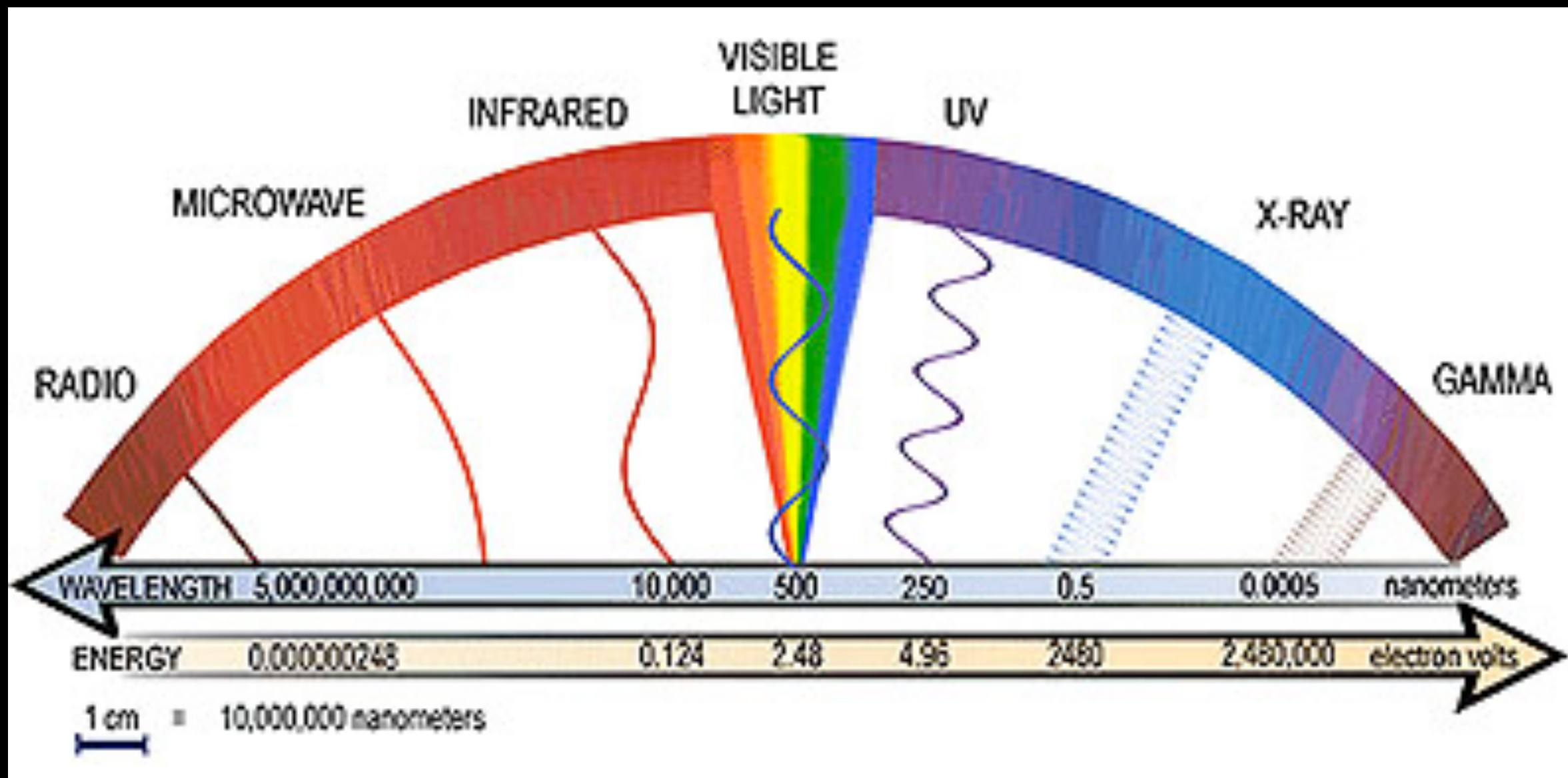
Although light behaves as a wave, under certain conditions, it also behaves as a particle.

- A particle of light is called a **photon**.
- You can think of a photon as a minimum-sized bundle of electromagnetic waves.



The amount of **energy** a photon carries depends on its **wavelength**.

- Shorter-wavelength photons carry more energy.
- Longer-wavelength photons carry less energy.





Light waves travel at the same speed as sound waves?

A) True

B) False

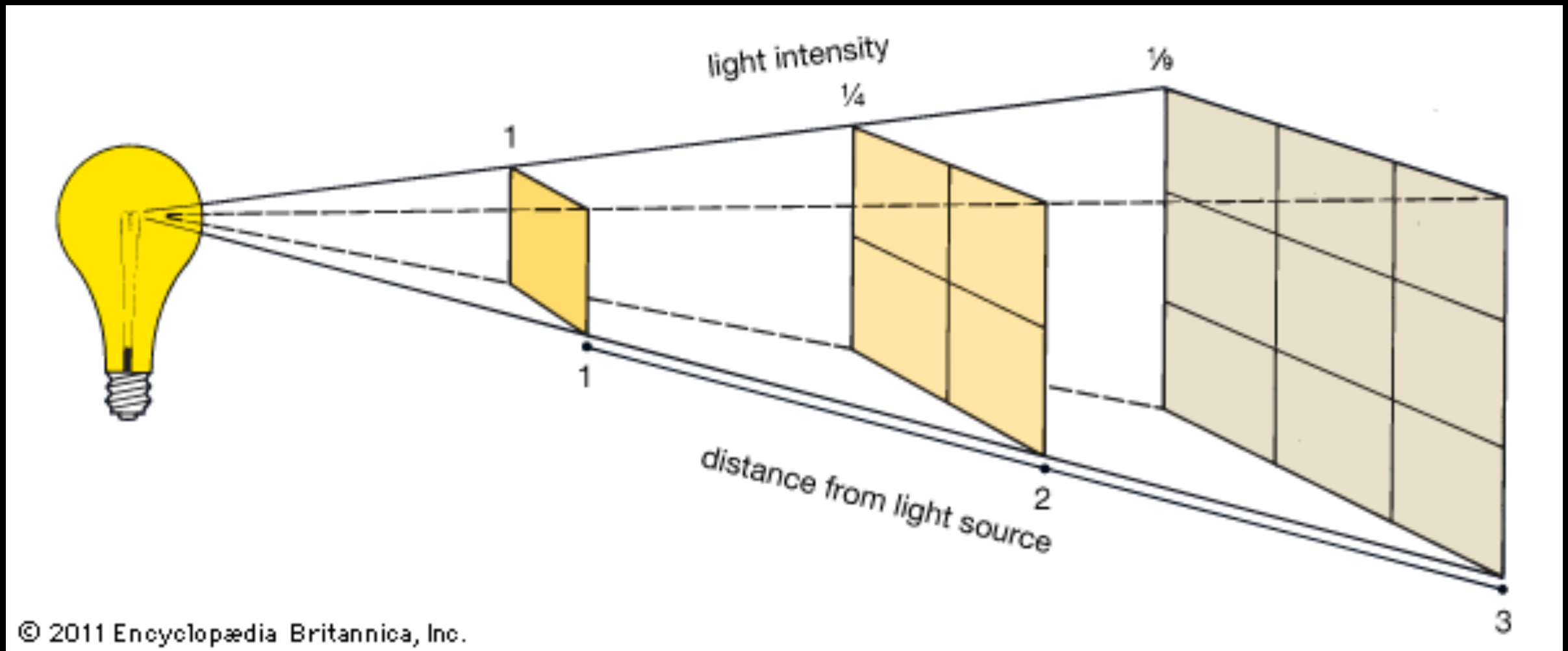
Light waves travel at the same speed as sound waves?

**False:** This is why you see the lightening and then hear the thunder.

Speed of light >> speed of sound



# Light follows an inverse square law



Amount of light hitting each square foot/meter goes down as  $1/d^2$ .

( $d$  = distance from central source)