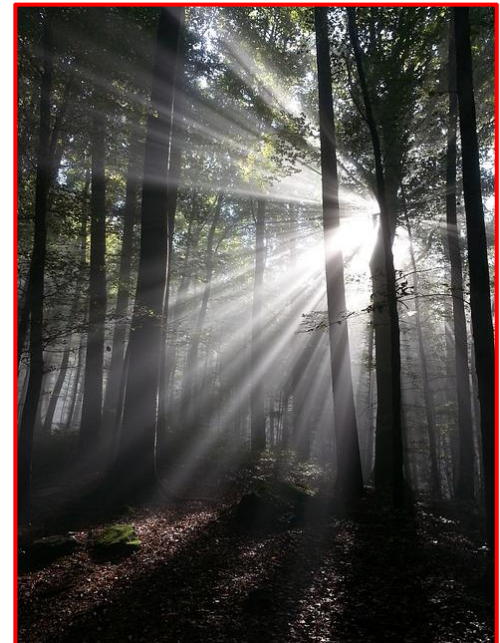
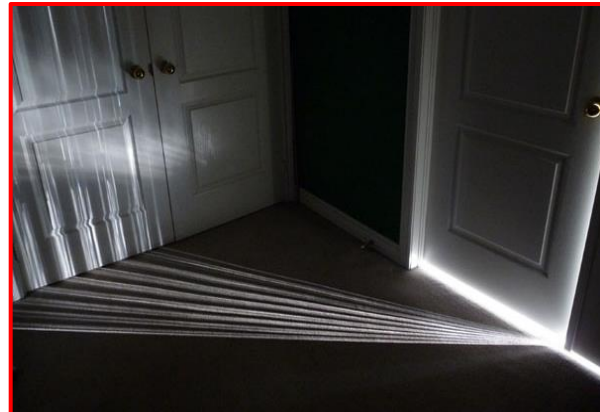
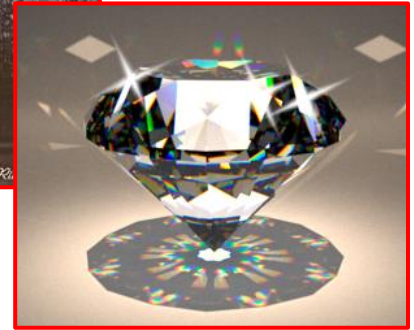


What Is Light?



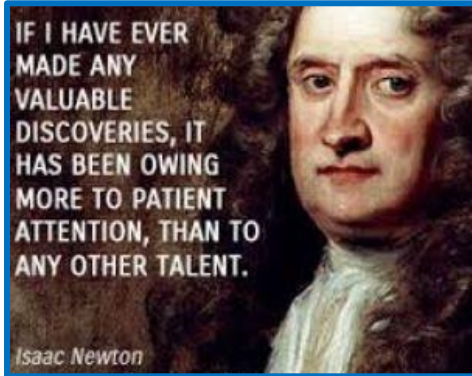
Observed Properties of Light

- Light travels in straight lines (*shadows*)
- Light can be bright or dim (*intensity*)
- Light can be different colors (*dispersion*)
- Light can bounce off surfaces (*reflection*)
- Light can, or cannot go through objects/substances (*transmission/absorption*)
- Light changes its speed/direction when entering different media (*refraction*)
- Light can bend at an opening or edge (*diffraction*)

... **WHAT IS LIGHT ?**

Nature of Light Debate

Isaac Newton, 1675:



light is made of **particles of energy (corpuscles)**. Explained reflection, shadows, traveling in straight lines.

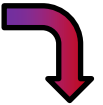


Christiaan Huygens, 1678:



"One may conceive light to spread successively, by spherical waves."

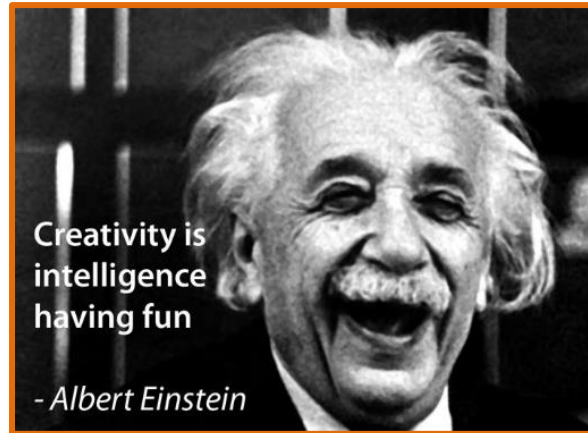
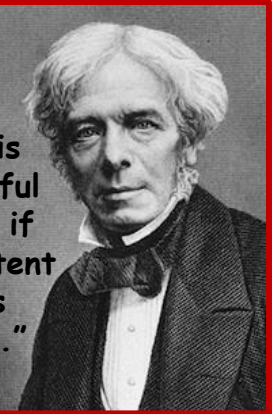
light is made of **waves in ether**. Explained diffraction, interference.



Michael Faraday, 1847:

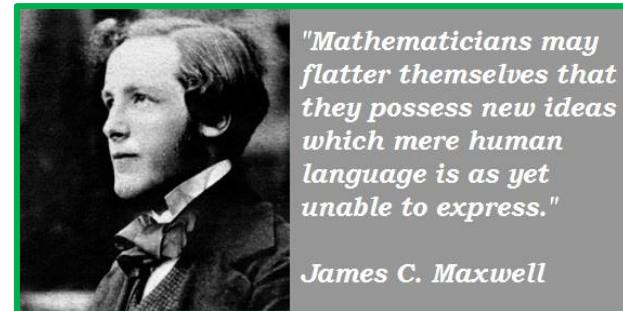
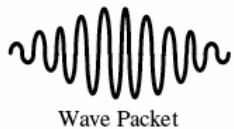
light is a **high-frequency electromagnetic vibration**, which could propagate even in the *absence of a medium*.

"Nothing is too wonderful to be true if it be consistent with laws of Nature."



Albert Einstein, 1905:

a beam of light is not a continuous wave propagating through space, but rather a **collection of discrete wave packets, photons**.



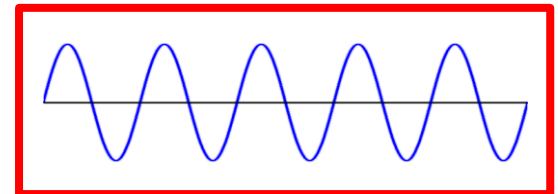
James Maxwell, 1864:
light is an **electromagnetic wave**.



Can we compare light to... ...the waves in the ocean?



***"High-low"
pattern behind
the obstacle***

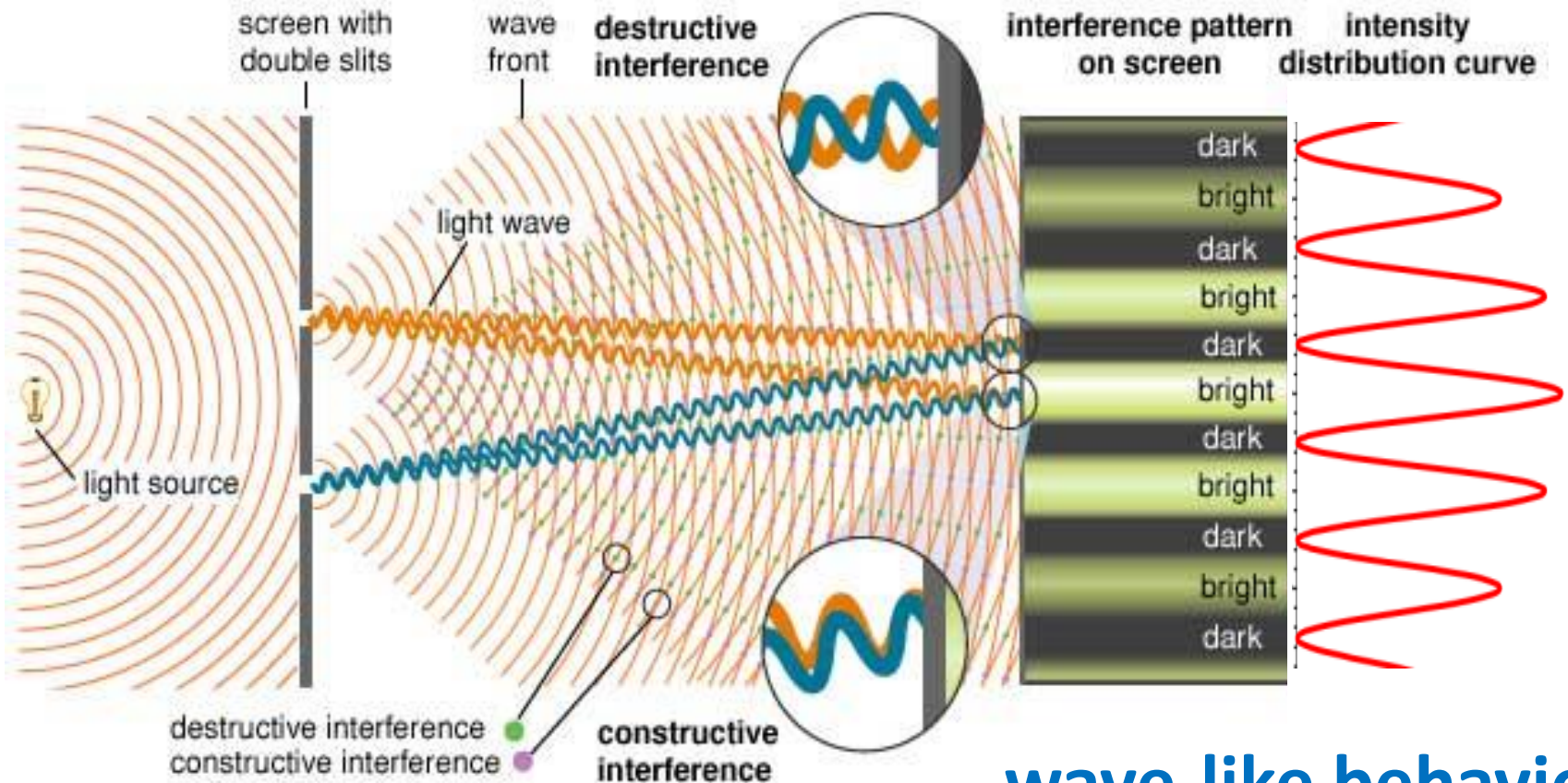


Double-Slit Experiment

Thomas Young, 1803



Light passing through two parallel slits will interfere, producing a *pattern of bright and dark fringes*.

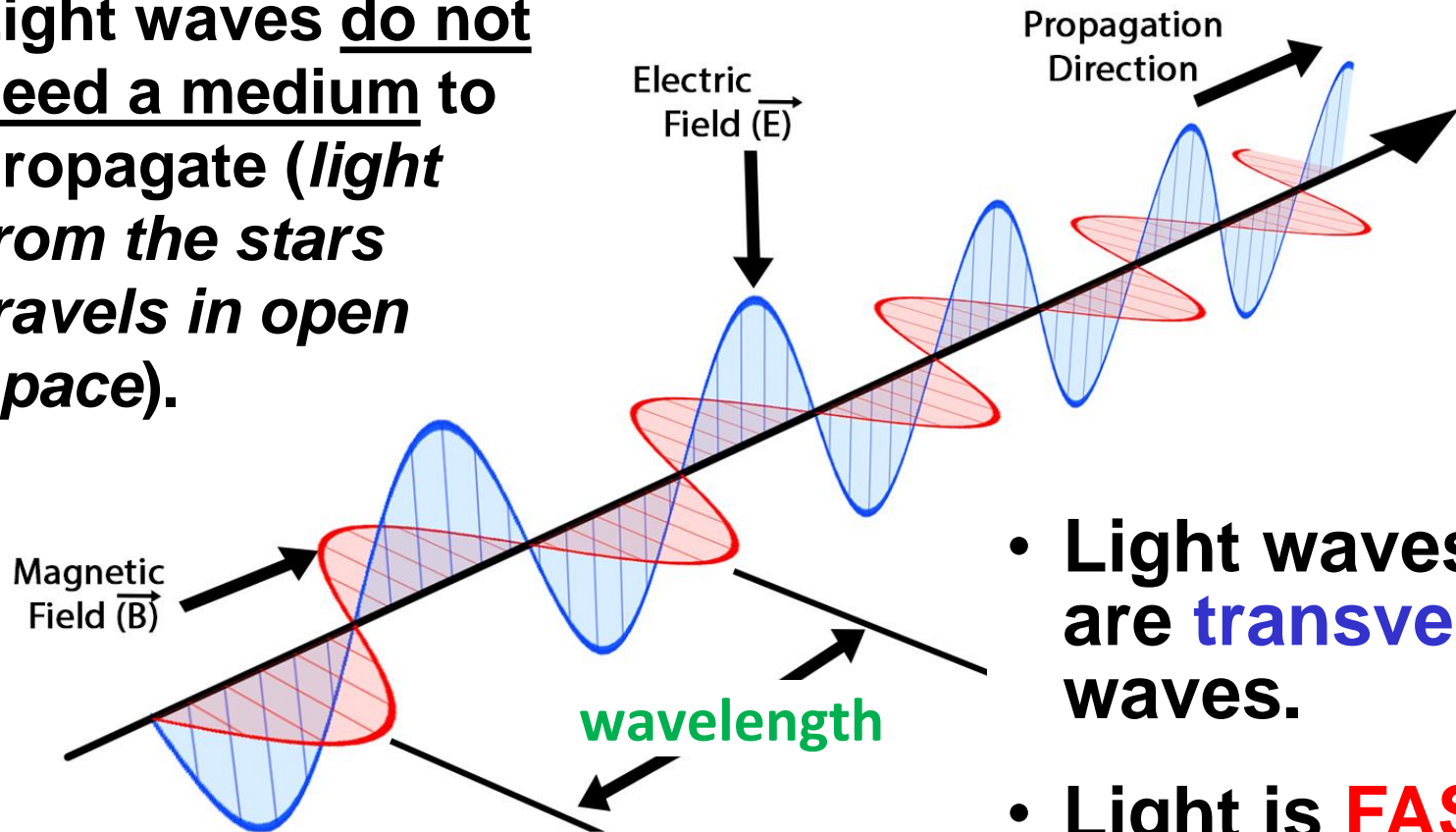


wave-like behavior

Light Waves

Light is an **electromagnetic wave** made of oscillations of *electric and magnetic field*.

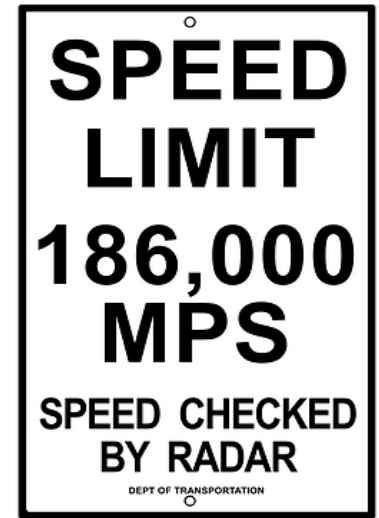
- Light waves do not need a medium to propagate (*light from the stars travels in open space*).



- Light waves are **transverse** waves.
- Light is **FAST!**

Speed of Light

The speed of light in a vacuum, denoted **C**, is **constant** throughout the Universe.



- **C** is the **maximum speed** at which all matter and information in the Universe can travel.
- **C = 299,792,458 meters/second** (approximate value of **~300,000,000 m/s** is commonly used for simple calculations)
- When light travels through matter, its speed can change (inside a *diamond*, light is *slowed down to less than 80,000 mps*), but can **never be larger than C**.

Speed of Light – How Fast?

- It takes **~8 minutes** for light to travel all the way **from the Sun to the Earth**.
- It takes **~ 4.4 years** for light from the nearest star, **Alpha Centauri**, to reach the Earth.

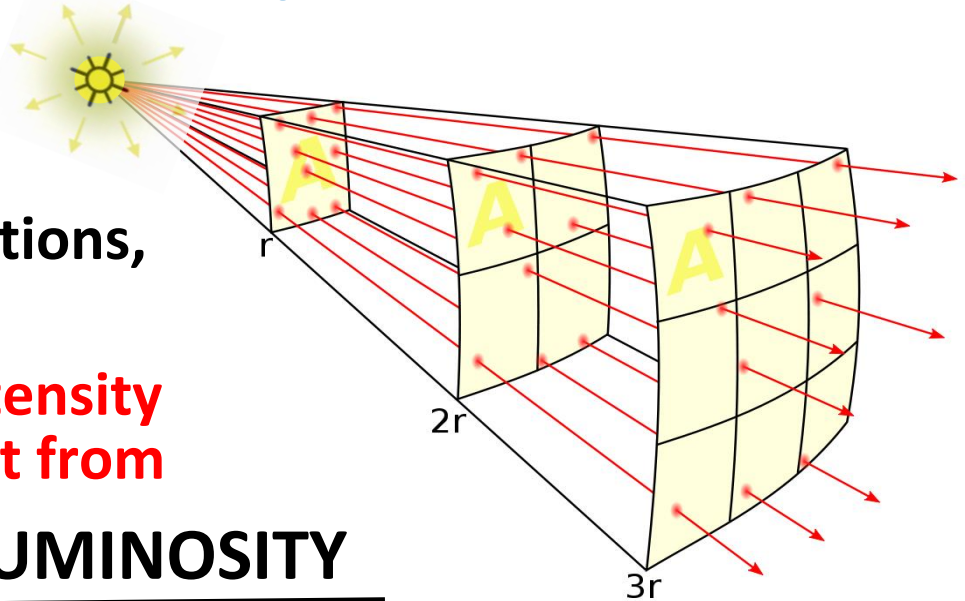


- It takes **~2.5 million years** for light from the nearest large galaxy, **Andromeda**, to reach our own galaxy, **the Milky Way**.

Light Intensity – How Bright?



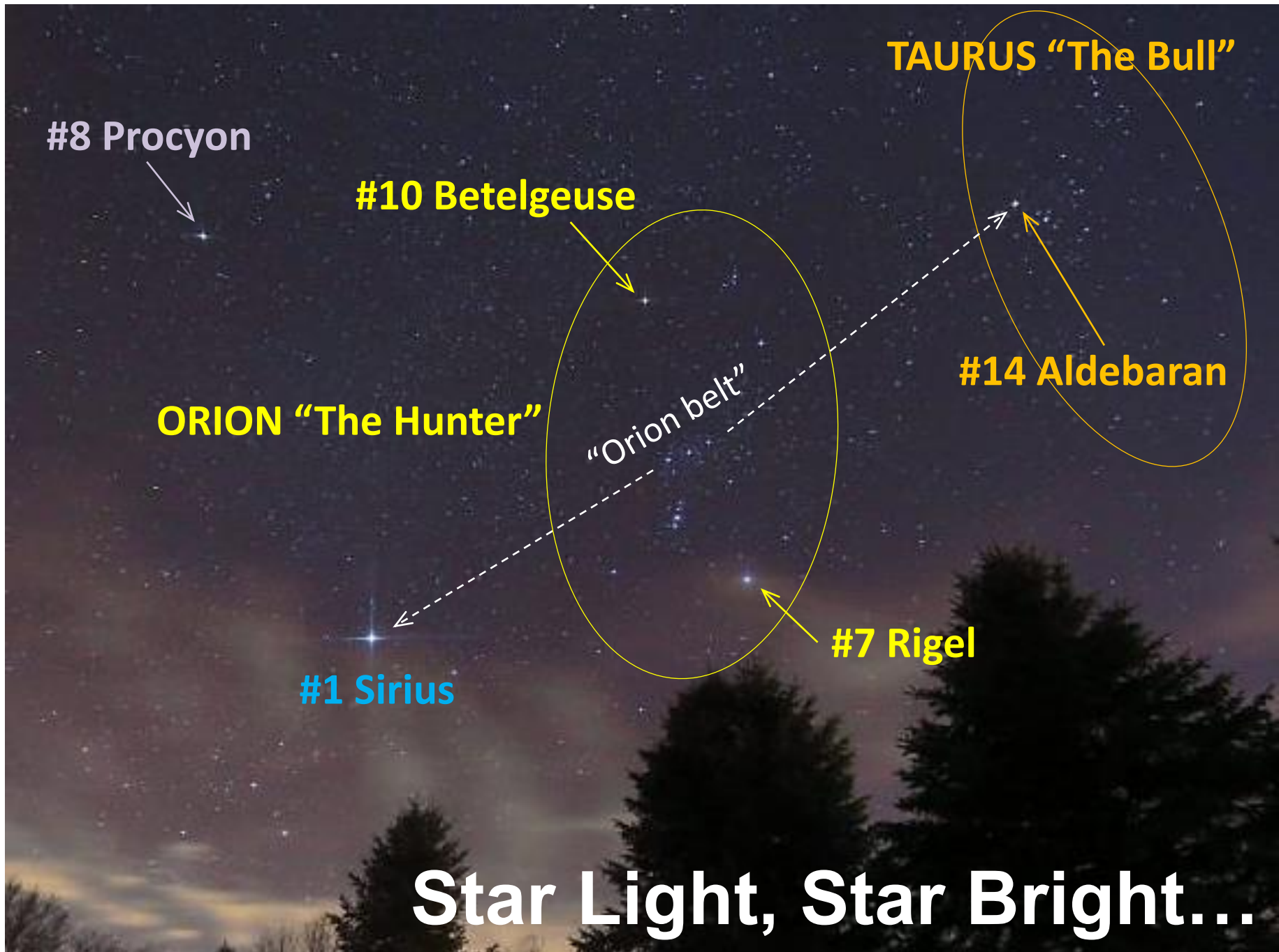
- The **total amount of light energy** a source radiates is called its luminosity.
- The intensity of light is the **amount of energy falling on a surface per a unit of time**.



- Most light sources distribute their light equally in all directions, making a **spherical** pattern.
- Light **spreads out** and the **intensity decreases** the farther you get from the source:

$$\text{INTENSITY} = \frac{\text{LUMINOSITY}}{4 \cdot \pi \cdot (\text{DISTANCE})^2}$$

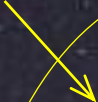
area of a sphere



#8 Procyon



#10 Betelgeuse



ORION "The Hunter"

"Orion belt"

TAURUS "The Bull"

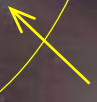
#14 Aldebaran



#1 Sirius



#7 Rigel



Star Light, Star Bright...

Star Bright...measured!

- Luminosity tells us how much energy a star radiates.
- Distance to stars is measured in *light years*.

Apparent brightness rank*	Star Name	Luminosity, solar units	Distance from Earth, light years	Luminosity rank*
1	Sirius	25	8.6	5
2	Rigel	150000	770	1
3	Procyon	7.7	11.4	6
4	Betelgeuse	100000	640	2
5	Aldebaran	500	65	4
6	Polaris	2200	430	3

* - of the most prominent stars in the pictured region of the sky only

Neither Sirius no Procyon are “truly brightest” stars at all!