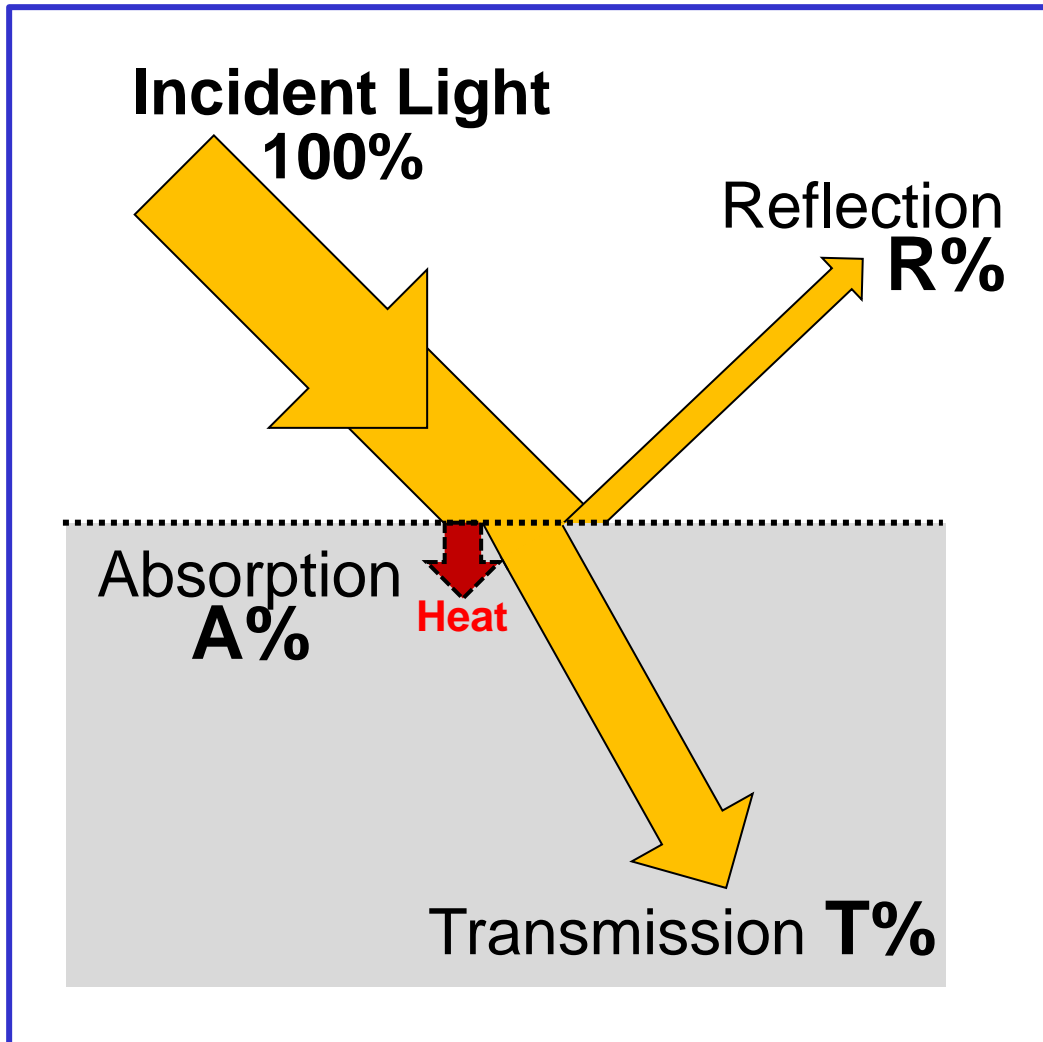


# Light Interaction with Non-Luminescent Matter



- Combination of transmission, reflection, and absorption:

$$T\% + R\% + A\% = 100\%$$

- No material is 100% transparent.
- No material is 100% absorbing either.

# How do we see *things*?

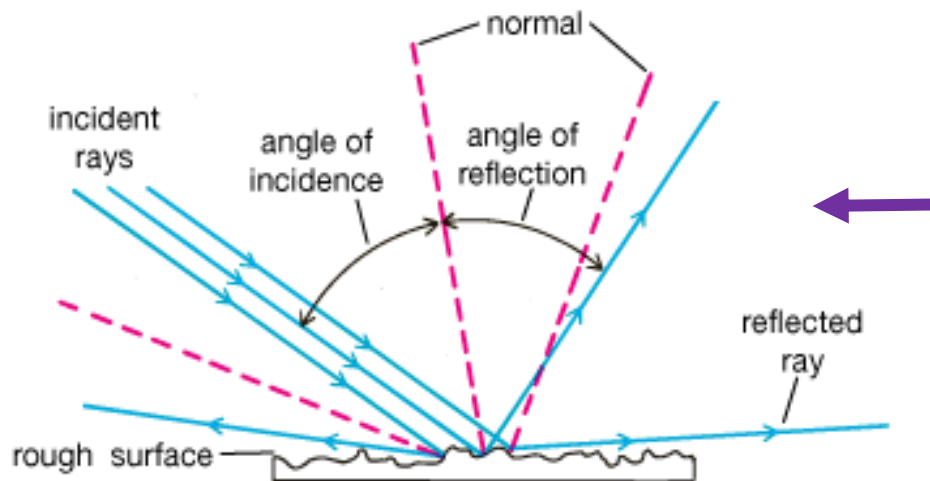
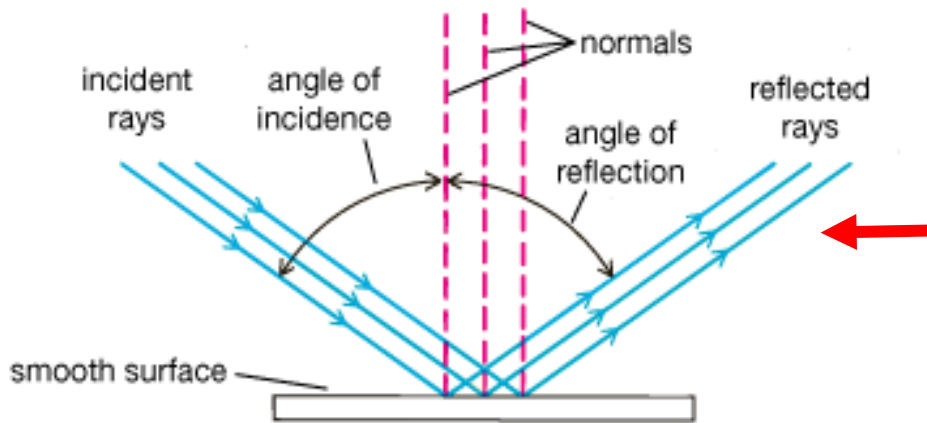
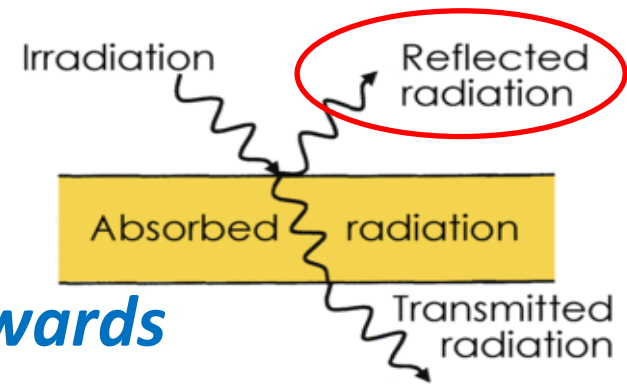
- When we see, we *sense light*.
- When we see an object, the light that reaches our eyes can come from two different processes:
  1. The light can be emitted directly from the object (object=light source), like a light bulb or glow stick.
  2. The light can come from somewhere else, like the Sun, and get reflected by the object.

**Most of the objects that we see are visible from *diffuse reflection*.**



# Reflection

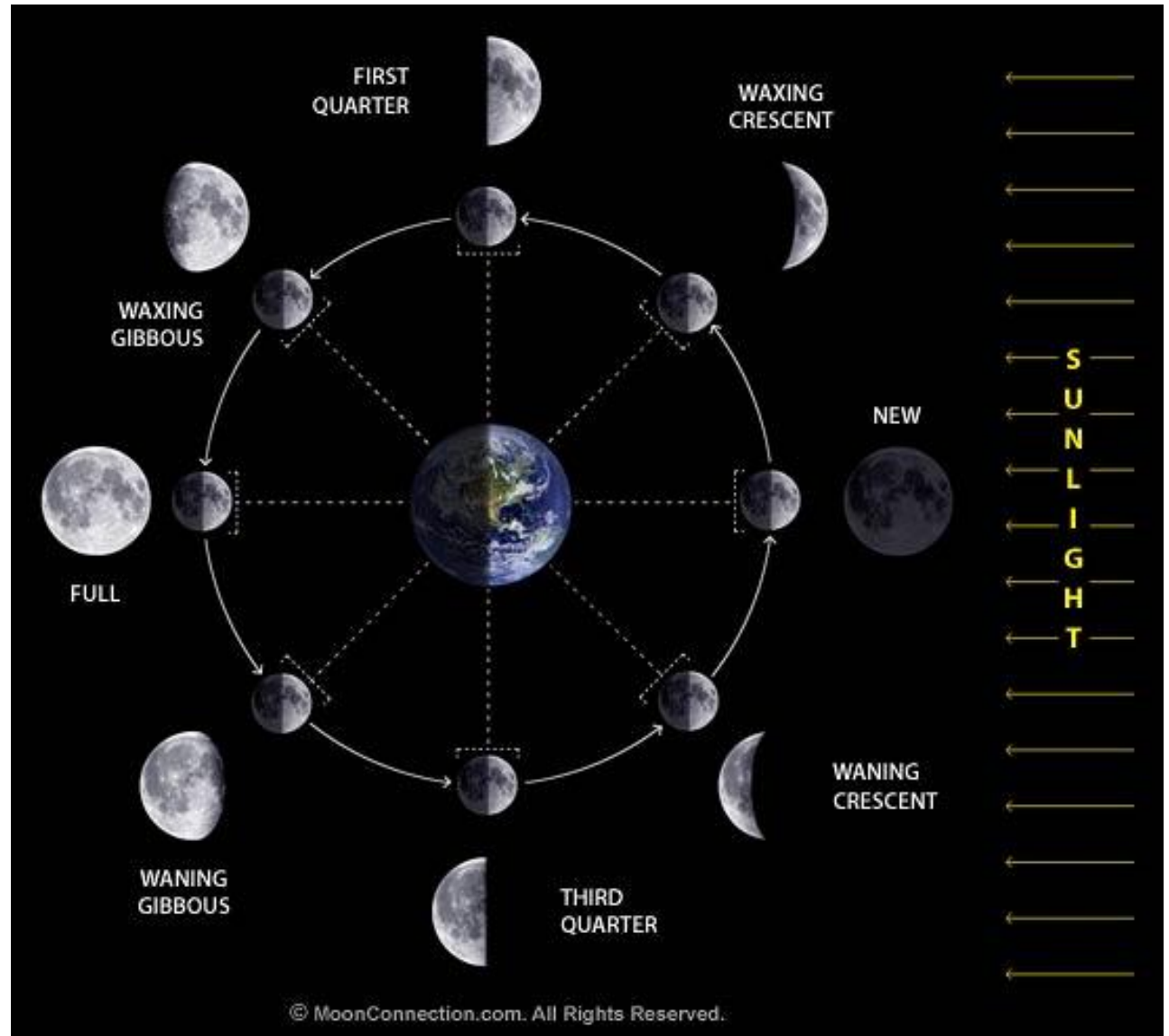
bouncing of light off the surface,  
change in the direction of travel *backwards*



- **Specular** reflection: if a surface is perfectly smooth, rays of light move out in definite directions.
- **Diffuse** reflection: if a surface is not smooth, the light rays are *scattered* in many random directions by microscopic details (irregularities).

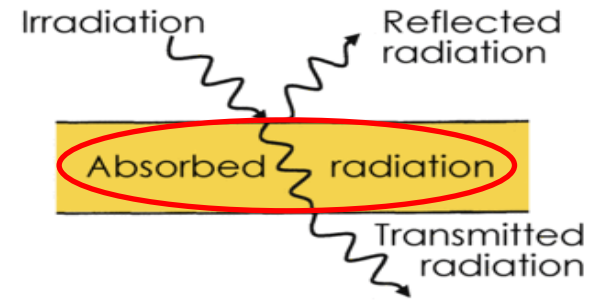
# Phases of the Moon

- Half of the Moon is always lit by sunlight.
- As the Moon revolves around the Earth, we see the lighted part of the Moon's surface from different angles.
- The different shapes we see are called "phases" of the Moon.

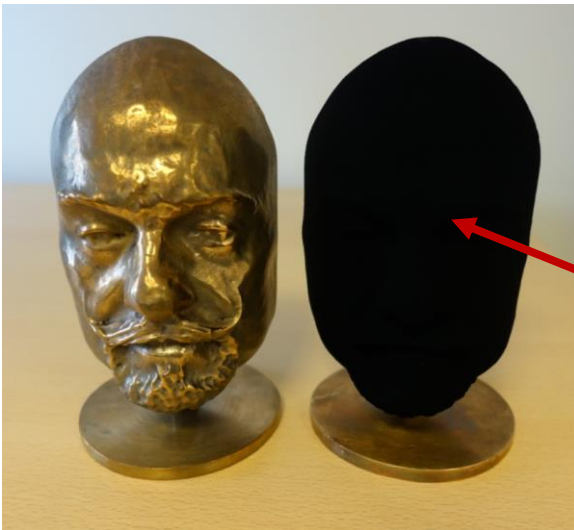


# Absorption

disappearance of a light wave



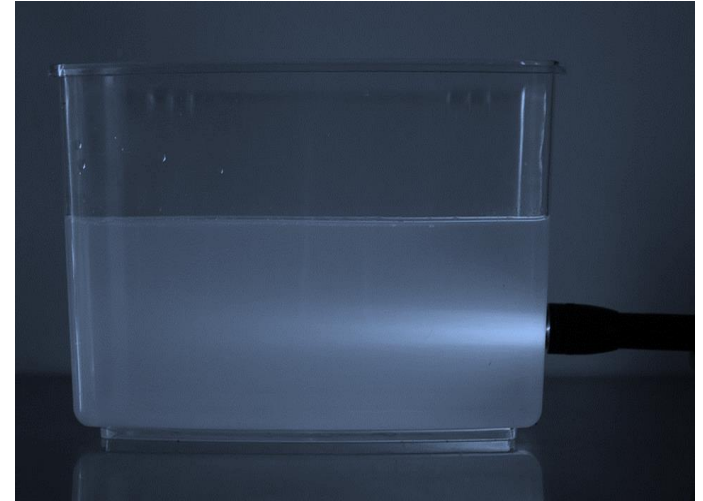
- The energy of a light wave is taken up by matter and in most cases converted into heat.
- **Dark opaque** objects absorb most of the incident light.



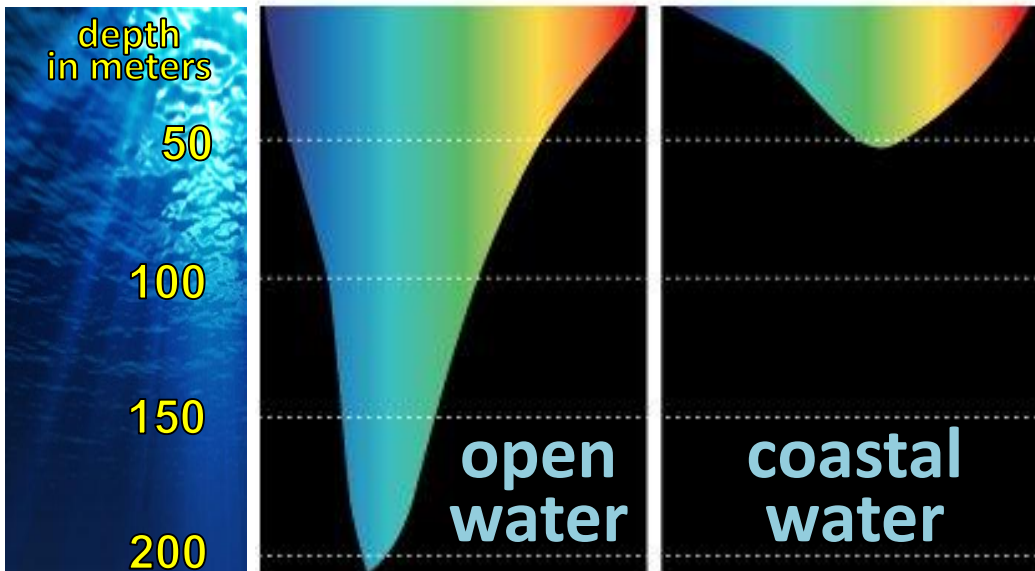
**Vantablack** – one of the darkest substances known, absorbing up to 99.965% of visible light!



**Transparent and translucent objects absorb some part of the incident light.**



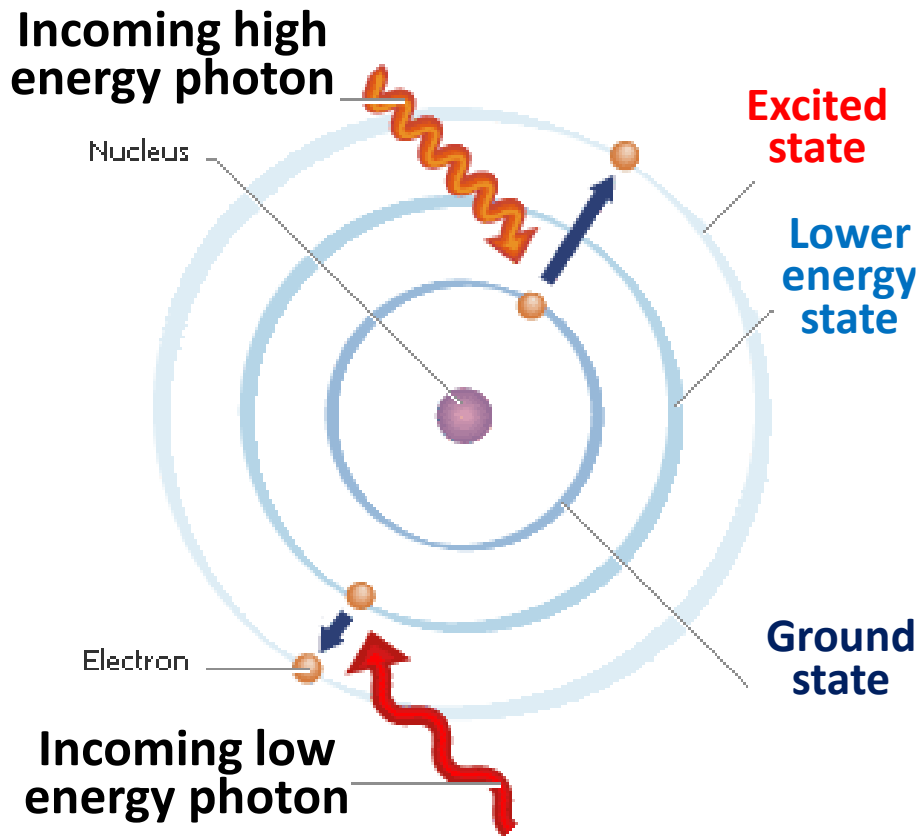
**Absorption of Sunlight by Water**





# Absorption Spectrum

**Absorption** of light can happen when the **photon energy** (i.e. *frequency*) **matches** one of the **allowed transitions** between energy levels of that particular atom.

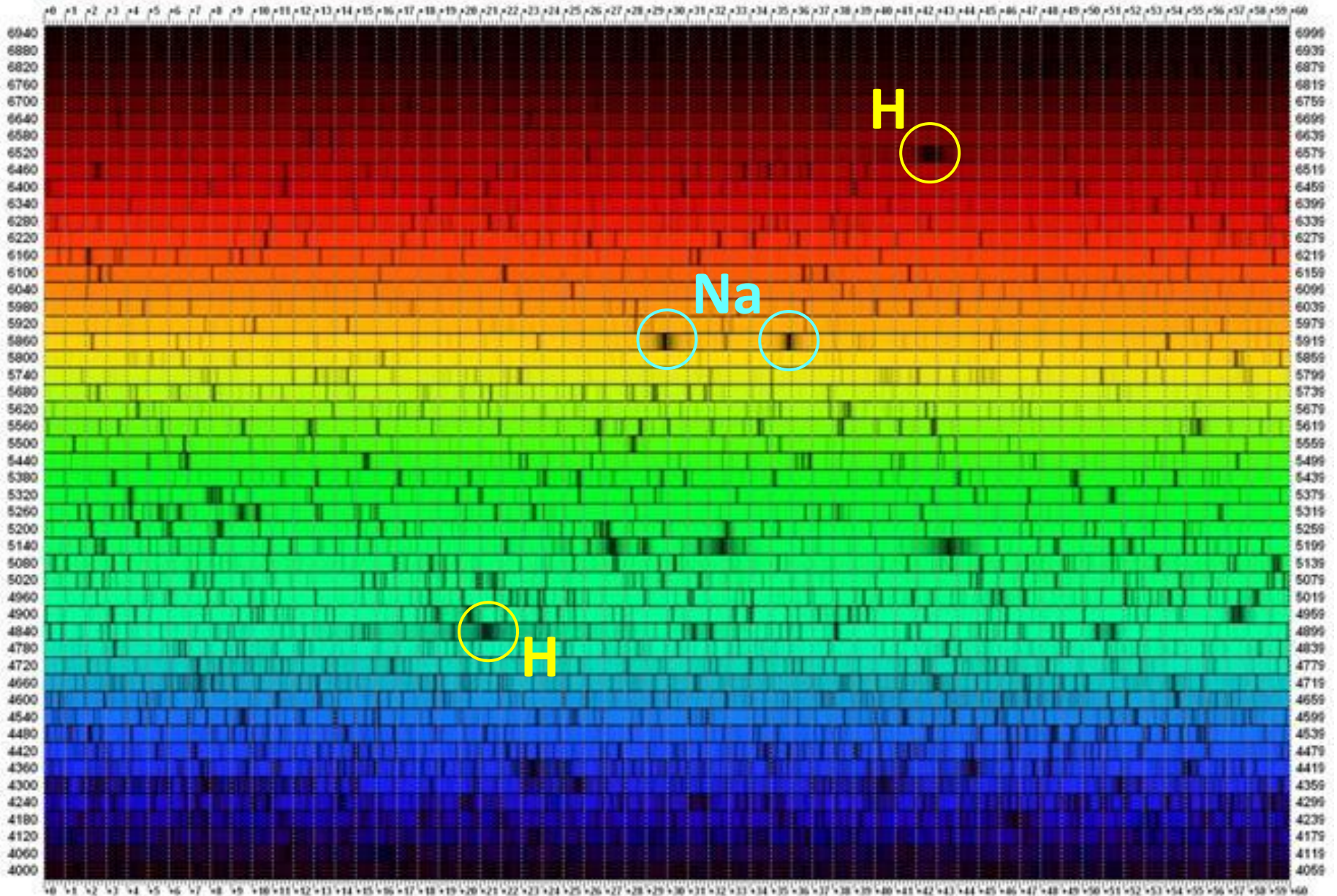


## Example: Hydrogen



A **star** will create an absorption line spectrum because the continuous spectrum emitted by the dense, opaque gas that makes up most of the star passes through the cooler, transparent atmosphere of the star.

# Absorption Spectrum of the Sun





# Sunlight Filtered through Atmosphere

Absorption of sunlight by various **gas molecules** that are present in the Earth's atmosphere is seen as **absorption bands** in the Sun spectrum.

