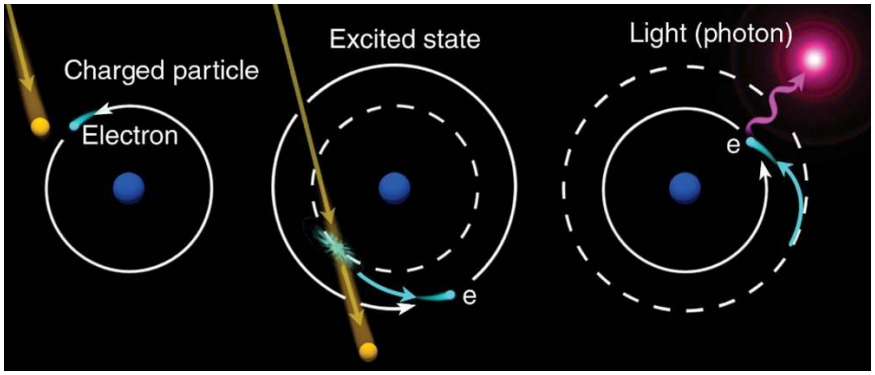
Line emission example:

Aurora (Northern Lights)

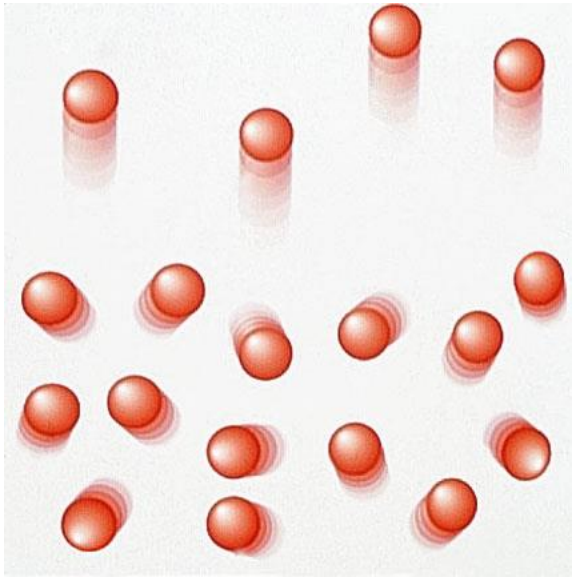
The aurora forms when charged particles emitted from the Sun (solar wind) get caught up in the Earth's magnetic field and collide with atoms and molecules in the top of the atmosphere.



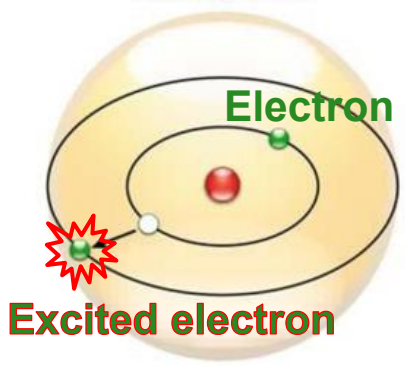
Different colors of the aurora are produced by different atmospheric components:

- **Red – oxygen atoms at ~200 miles high**
- **Blue – ionized nitrogen molecules**
- **Green-Yellow – oxygen atoms at ~60 miles high – most common!**
- **Pink/crimson/purple – mix of the above**

Gases

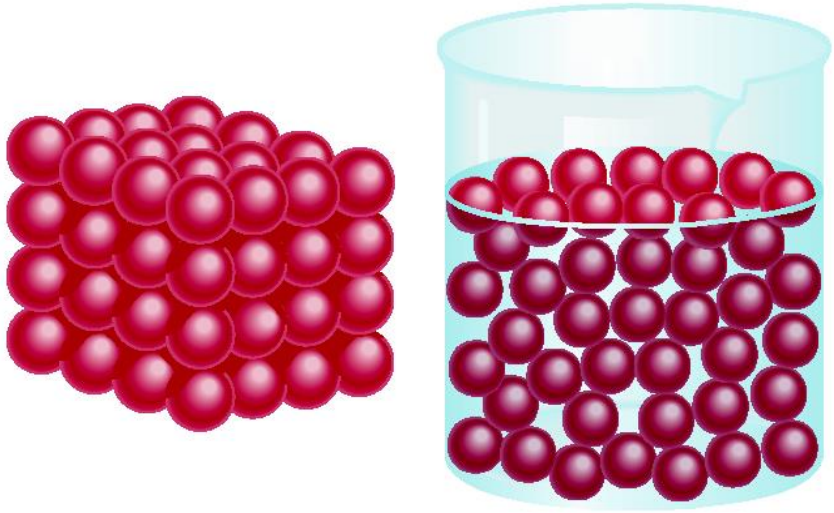


atoms far apart

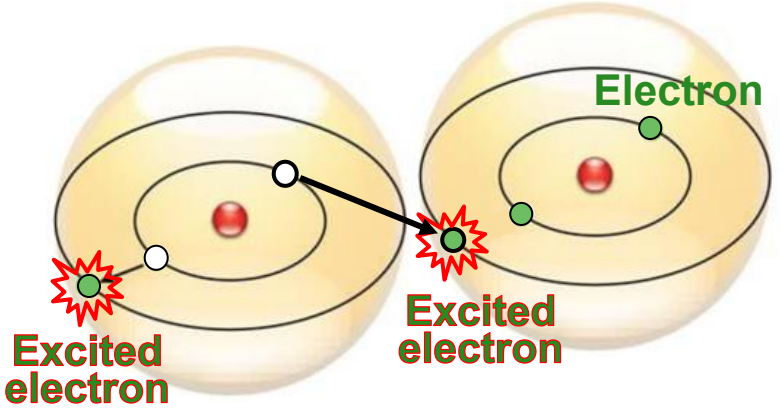


VS

Solids/Liquids

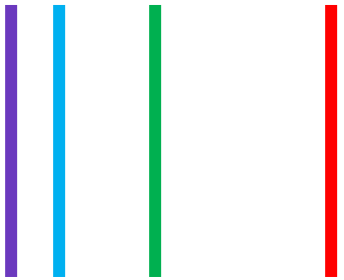


atoms close to each other

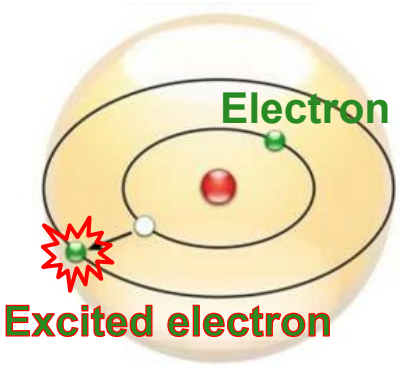


Gases

atoms far apart



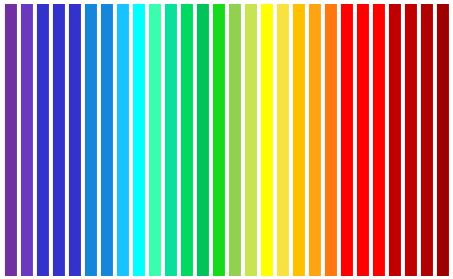
limited set of distinct colors



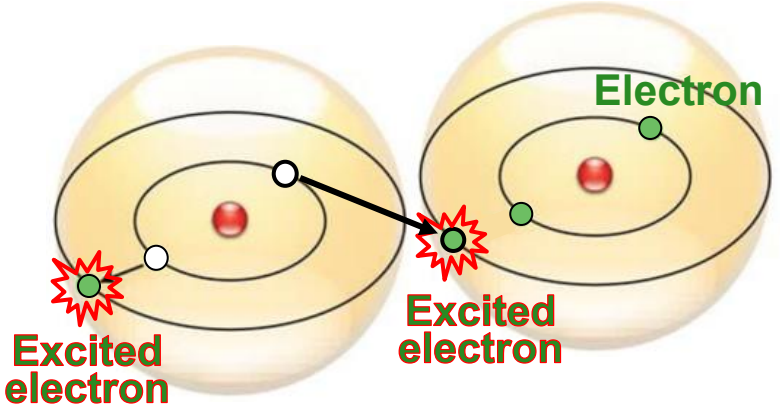
VS

Solids/Liquids

atoms close to each other



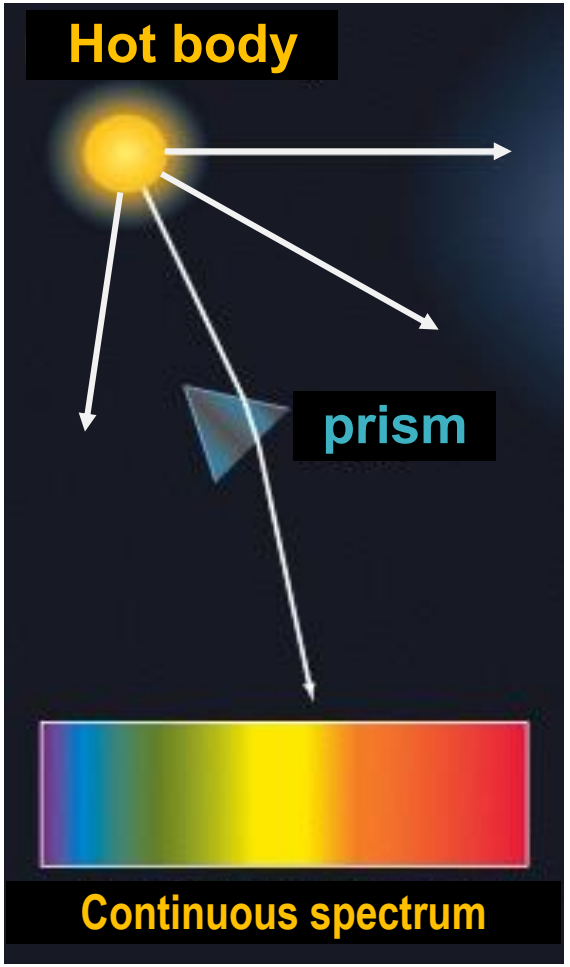
much greater number of possible colors



Thermal Radiation

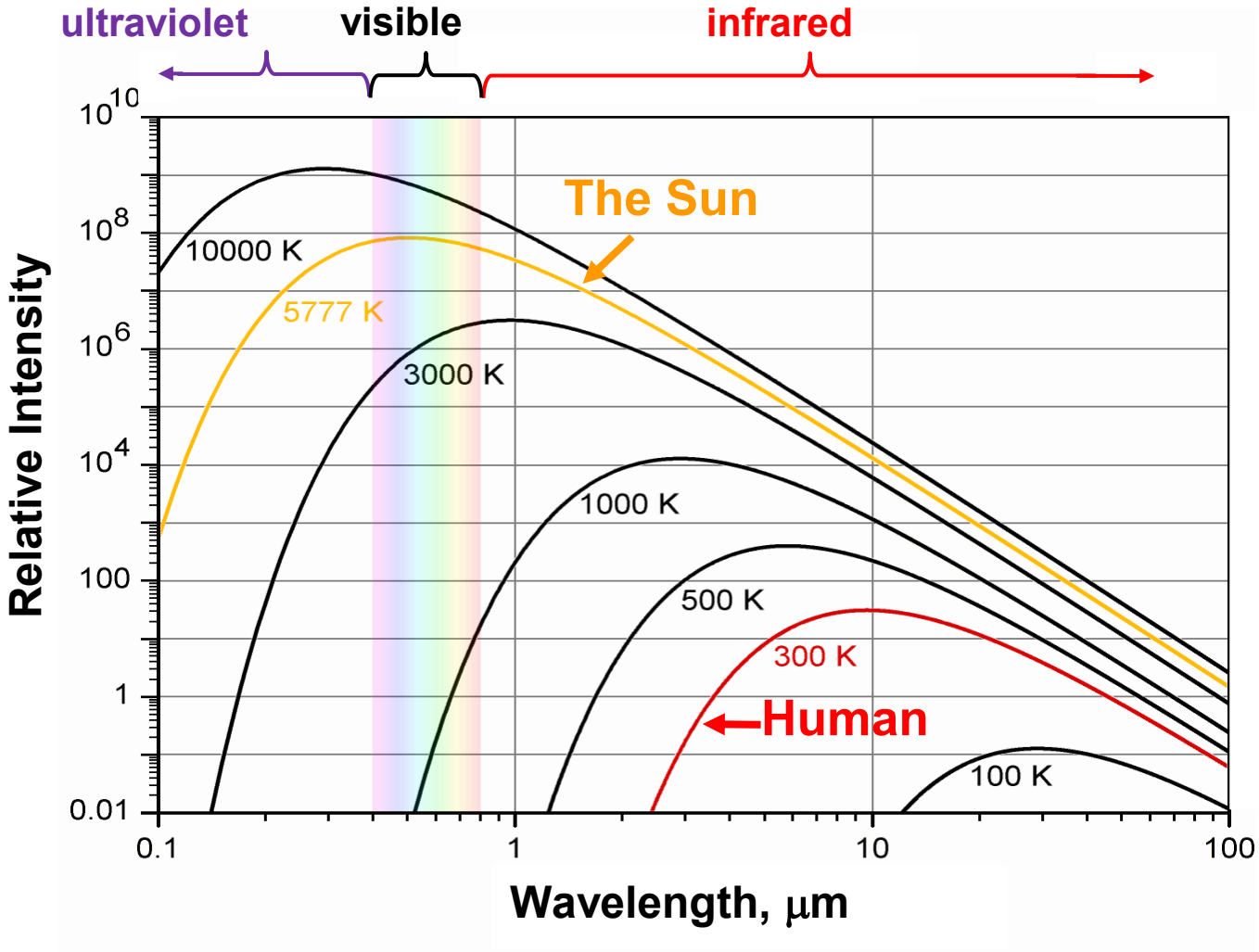
All normal matter emits electromagnetic radiation when it has a temperature above absolute zero.

- This radiation represents a conversion of a body's thermal (heat) energy into electromagnetic energy, and is therefore called **thermal radiation**.
- When the atoms are in a condensed state (solid or liquid matter), the "hot" electrons can make transitions not only within the energy levels of their own atom, but also between the levels of neighboring atoms (that can be of same or different kind).
- This results in a **much larger number of possible transitions** with corresponding frequencies of radiant energy, producing a **continuous color spectrum**.



Thermal Radiation Spectrum

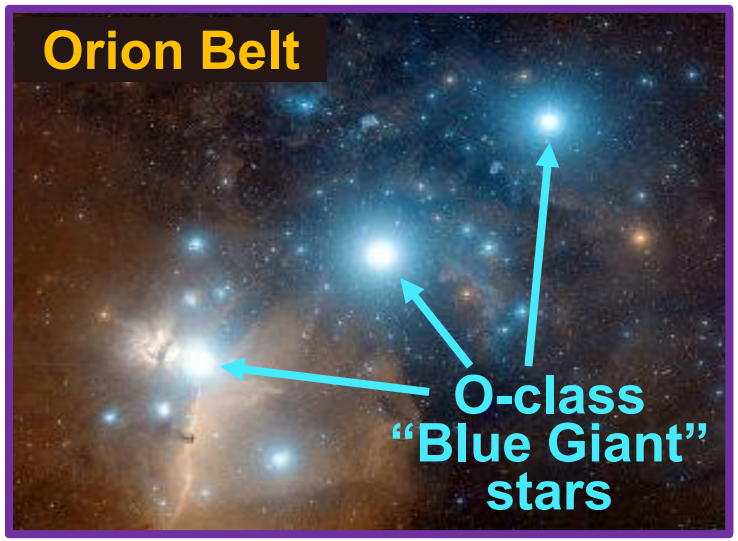
The exact thermal radiation spectrum depends upon properties of the material and the temperature.



In general, as the temperature increases, the peak of the radiation curve moves to higher intensities and shorter wavelengths.

Everything Glows!

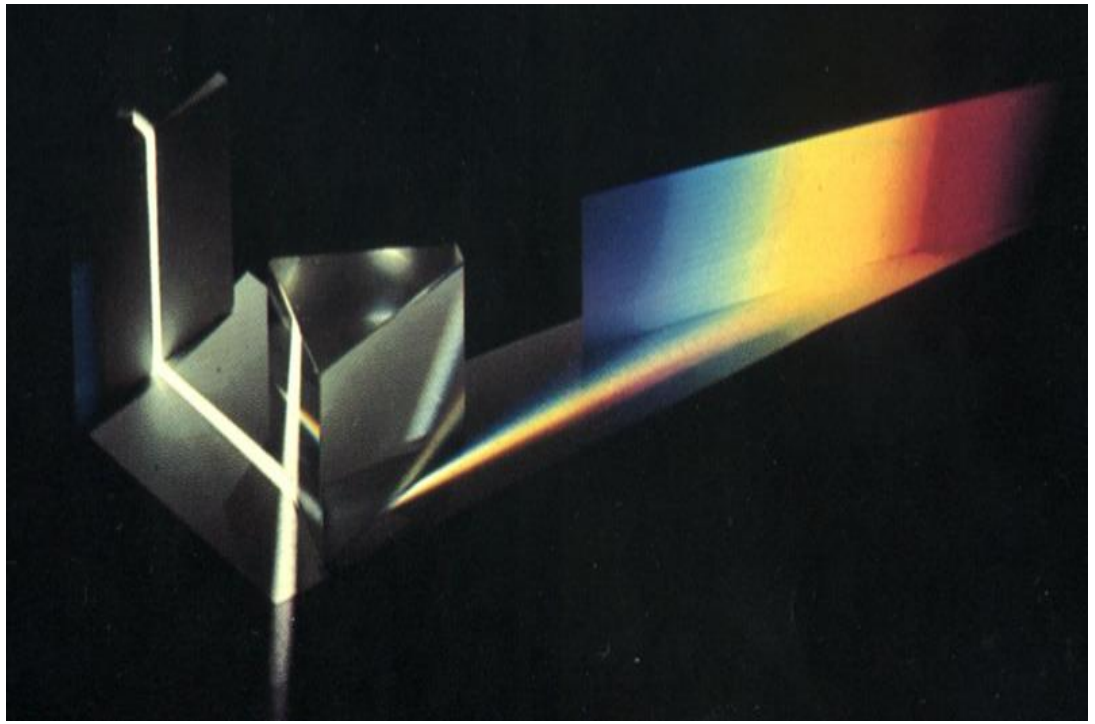
- The temperature at which all solids glow a dim red is about 800 K (over 500℃ or 900℉).



- A very hot object (10,000 K) would emit a significant amount of energy in the ultraviolet and x-ray region of the spectrum.

- People are emitters of light in the infrared region (peak ~9.5μm).

Light meets Matter

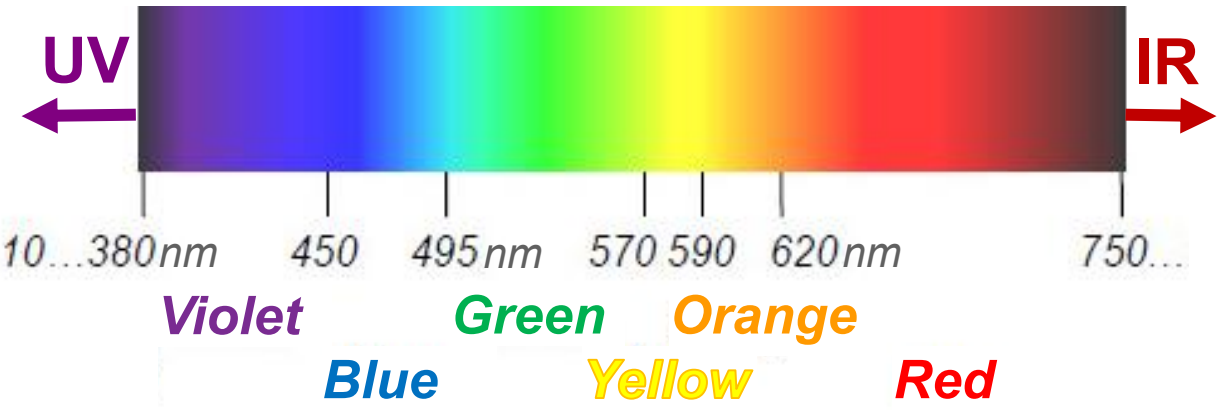


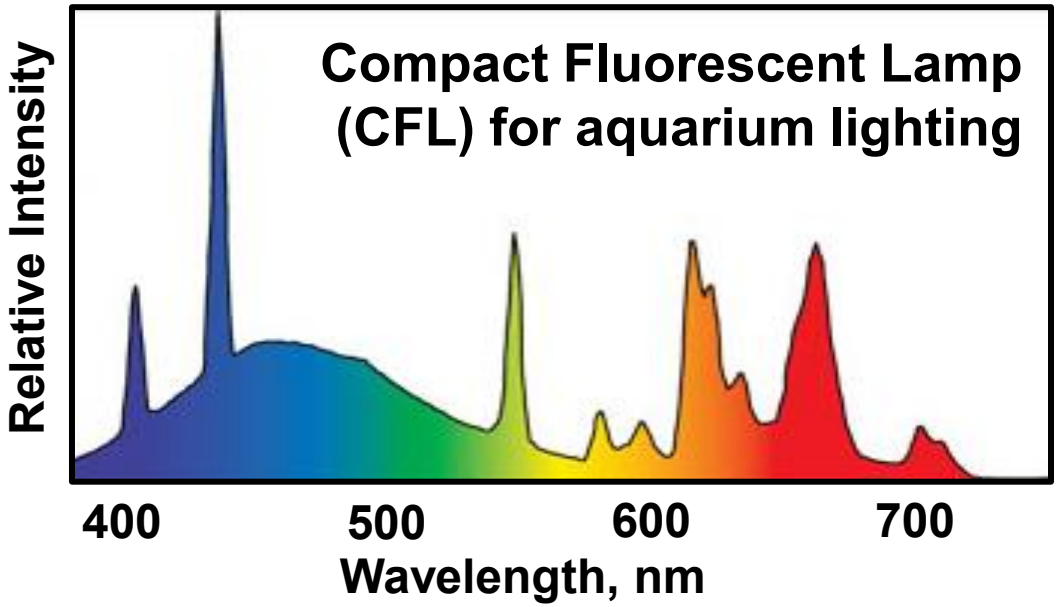
Describing Light

1. Wavelength:
type of photon

2. Intensity:
amount of photons

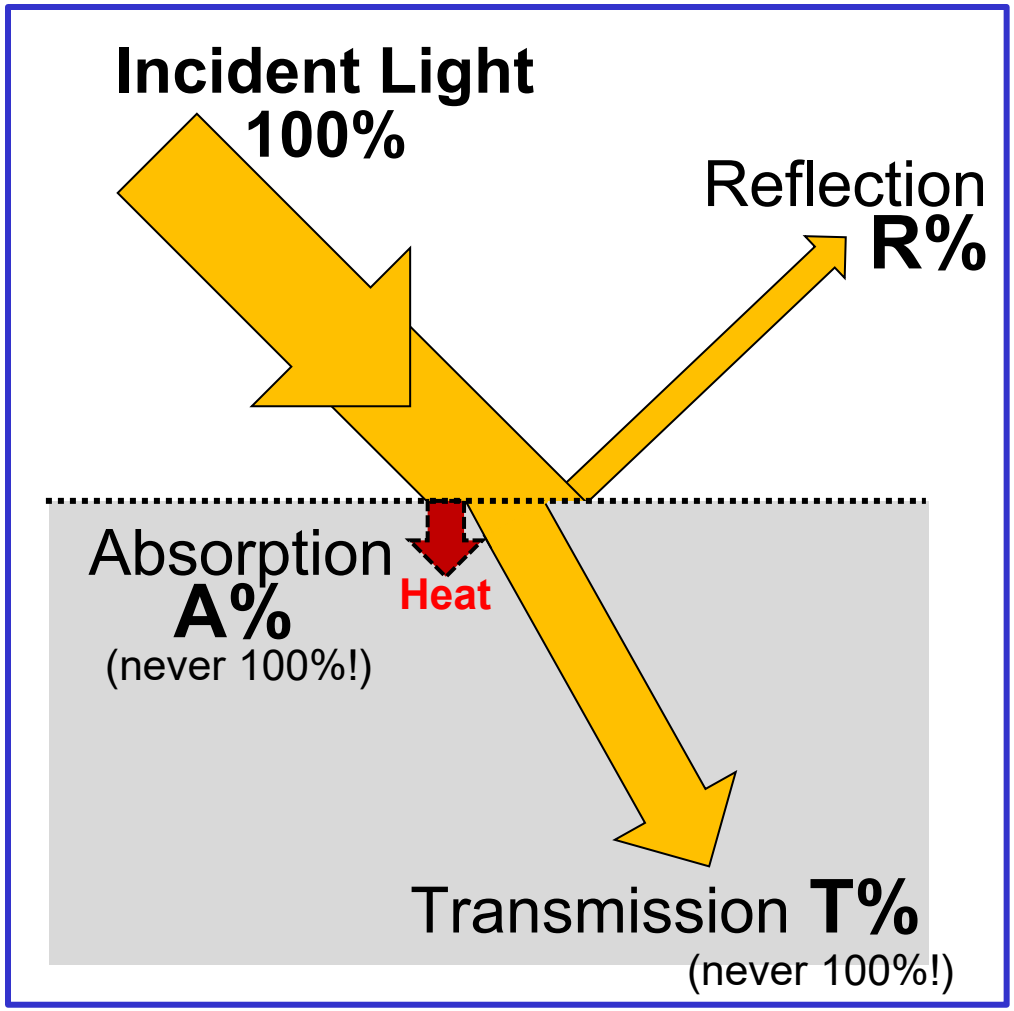
3. Spectrum:
composition of light; types of photons and their relative abundance





What (always) happens to light?

The material world around us can be viewed as objects (substances, materials) and boundaries (surfaces, interfaces).



Light (energy!) can be reflected, transmitted or absorbed by matter.

T%+R%+A%=100%

What *exactly* happens to light waves depends on the nature of the material, the smoothness of the surface, the angle of incidence, and the light wavelength.