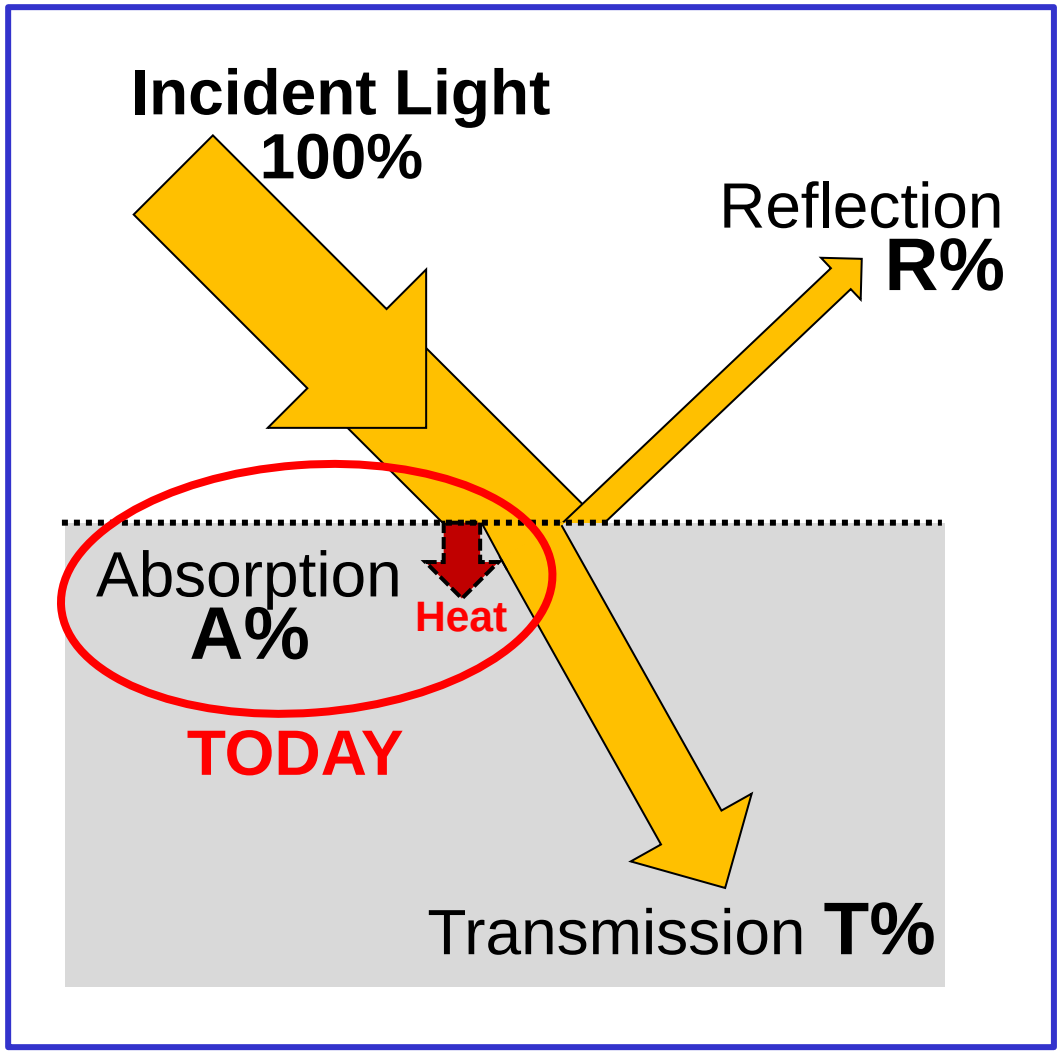
Light Interaction with Non-Luminescent Matter



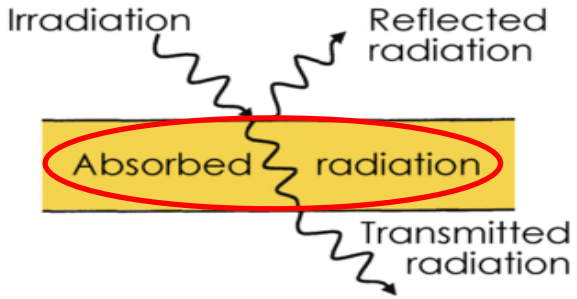
- **<u>Combination</u> of transmission, reflection, and absorption:**

T%+R%+A%=100%

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

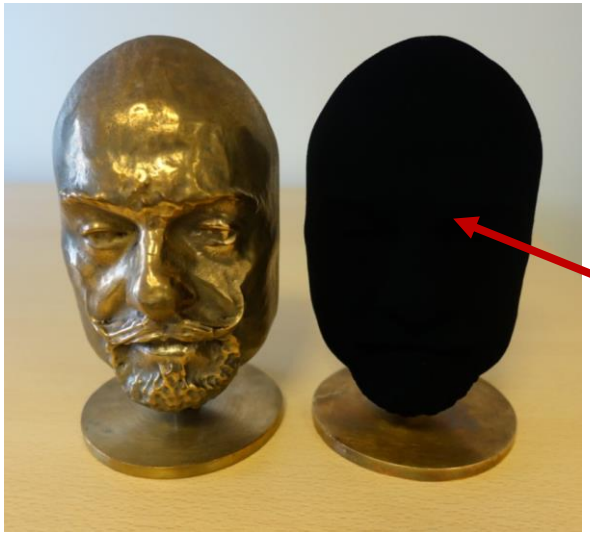
Absorption

disappearance of a light wave



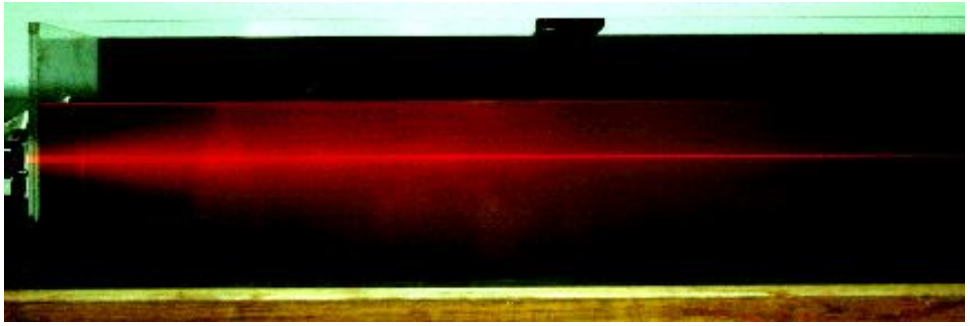
- The <u>energy of a light wave is taken up by matter</u> and in most cases converted into heat.

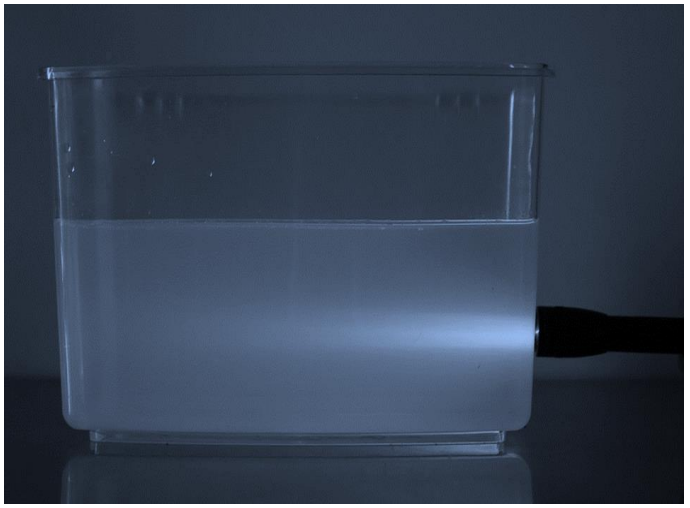
- **Dark opaque** objects **absorb most** of the incident light.



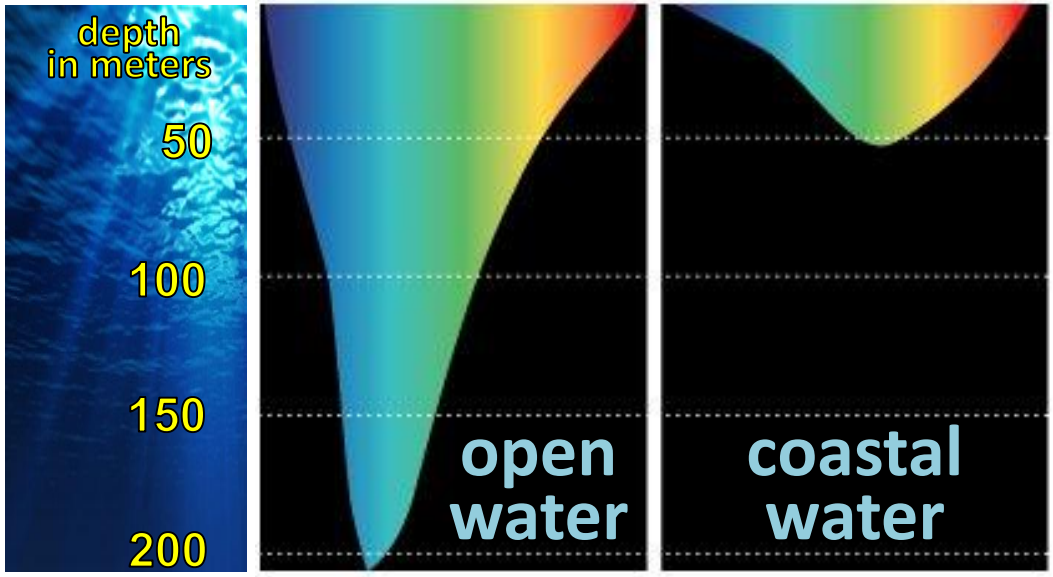
Vantablack – one of the darkest substances known, absorbing up to 99.965% of visible light!

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



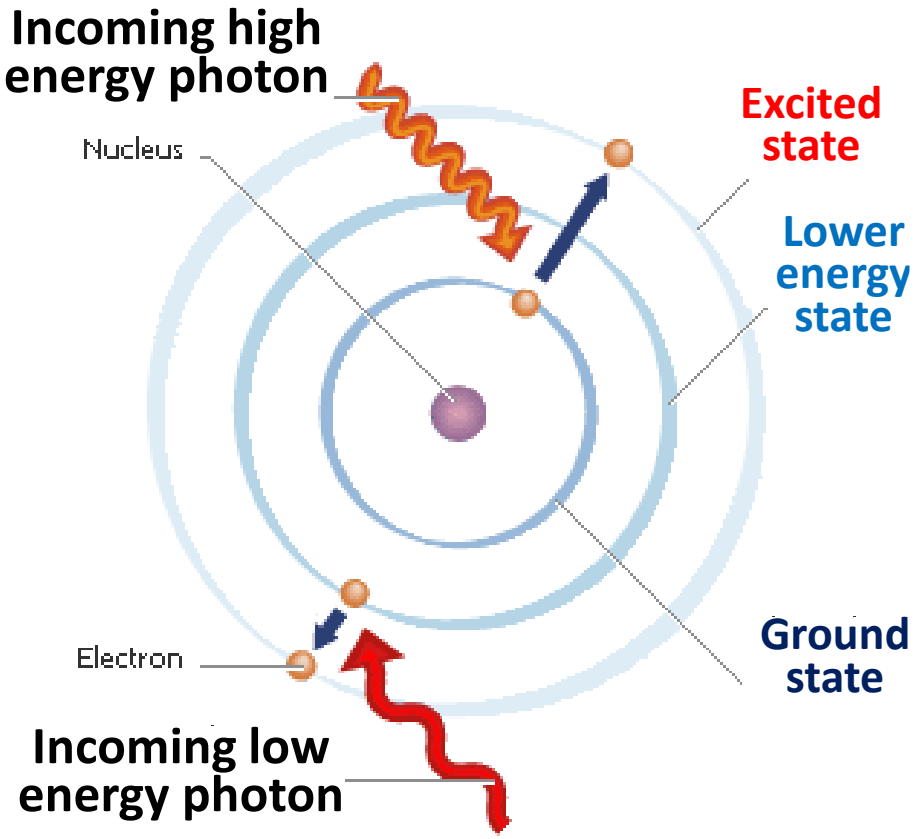


Absorption of Sunlight by Water



Absorption Spectrum

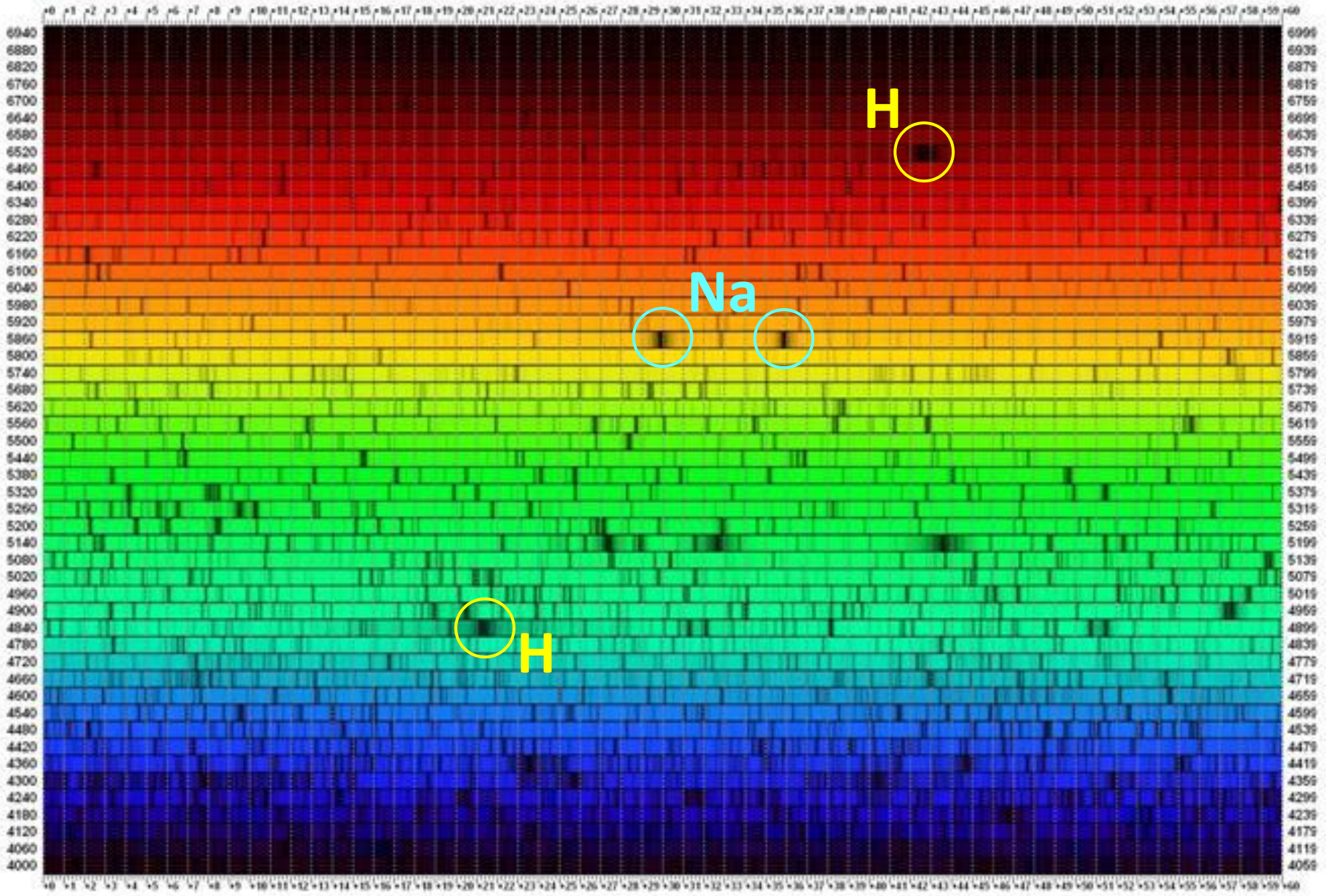
Absorption of light can happen when the photon energy (i.e. *frequency*) matches one of the allowed transitions between energy levels of that particular atom.



Example: Hydrogen

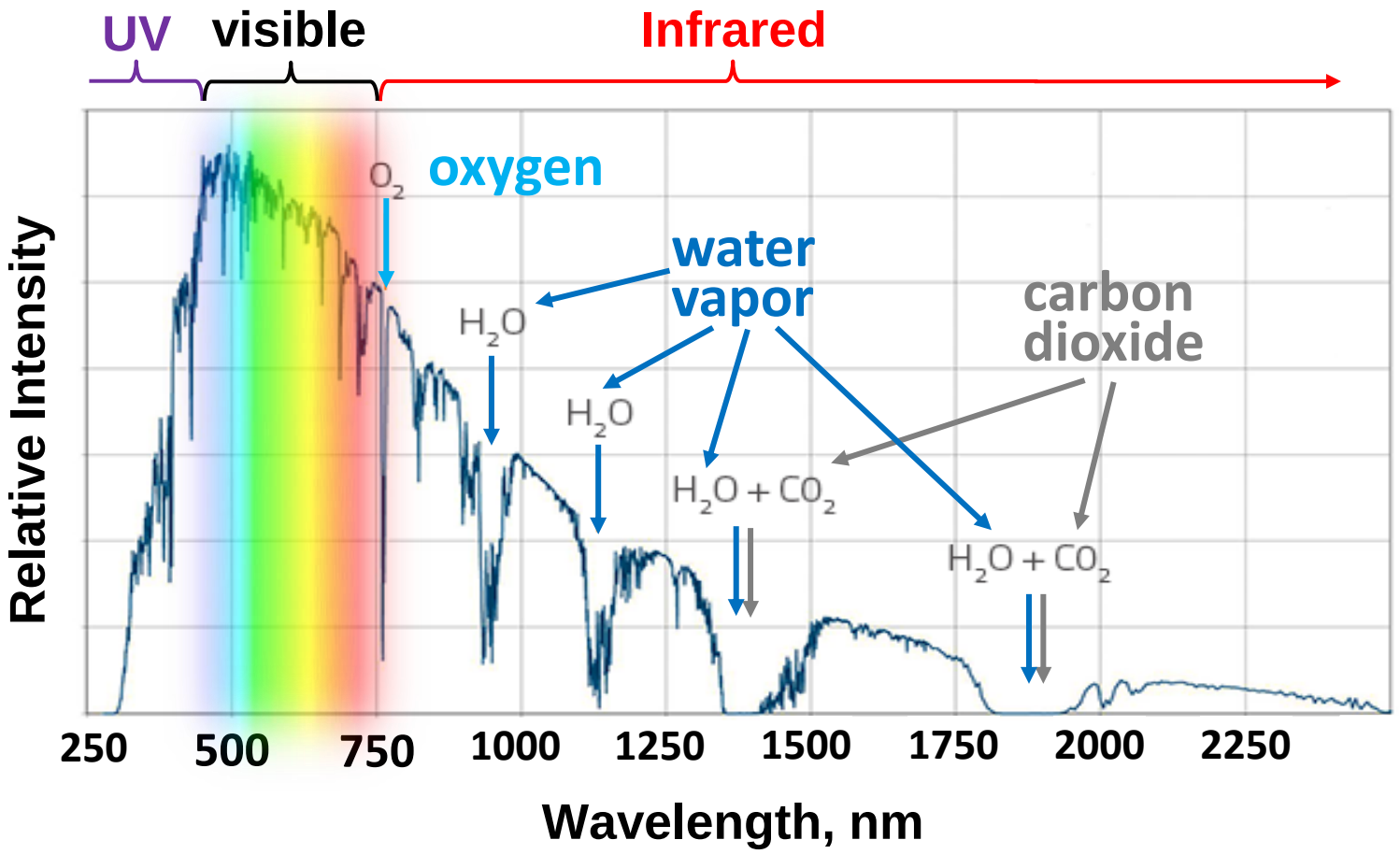
A star will create an absorption line spectrum because the continuous spectrum emitted by the dense, opaque gas that makes up most of the star passes through the cooler, transparent atmosphere of the star.

Absorption Spectrum of the Sun



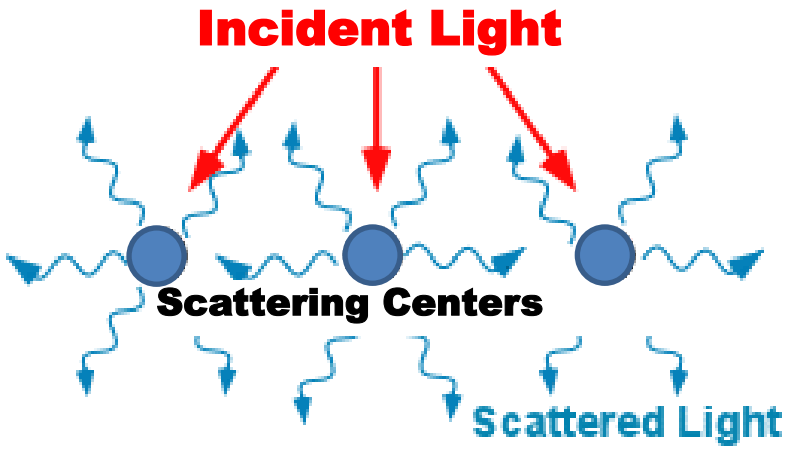
Sunlight Filtered through Atmosphere

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



Scattering

light ray moves over to the side in all directions rather than forward, backward or being absorbed



- Scattering is due to **localized non-uniformities *(scattering centers)*** in the medium through which light passes.
- The **most critical factor** is the **scattering centers size relative to the wavelength of the light** being scattered.
- Amount of the **scattered light can strongly depend on the wavelength** of light.

I See Skies of Blue…

Sunlight contains all the colors.

Atmospheric molecules **scatter** light

Longer path through atmosphere means more scattering.

At sunset, violet, blue and green are completely scattered away, but red and orange are still there!

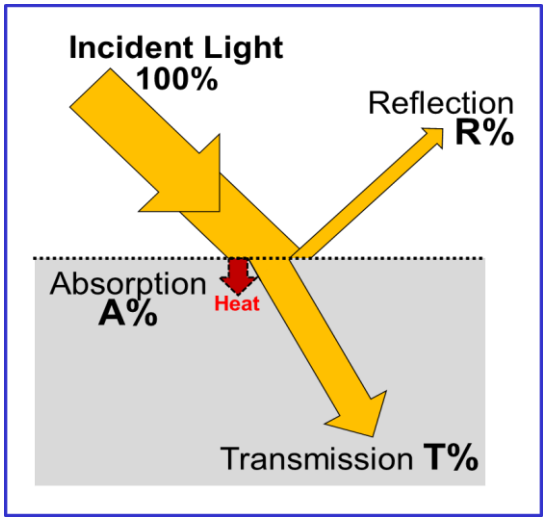
Violet and blue are scattered most…

…we see blue because our sensitivity to violet is very low!

…and Red Sunsets too!

Guess an object !

T=0
R~70%
A~30%



T=0
R~5%
A~95%

T~95%
R~5%
A~0%

Transmitted%+Reflected%+Absorbed%=100%