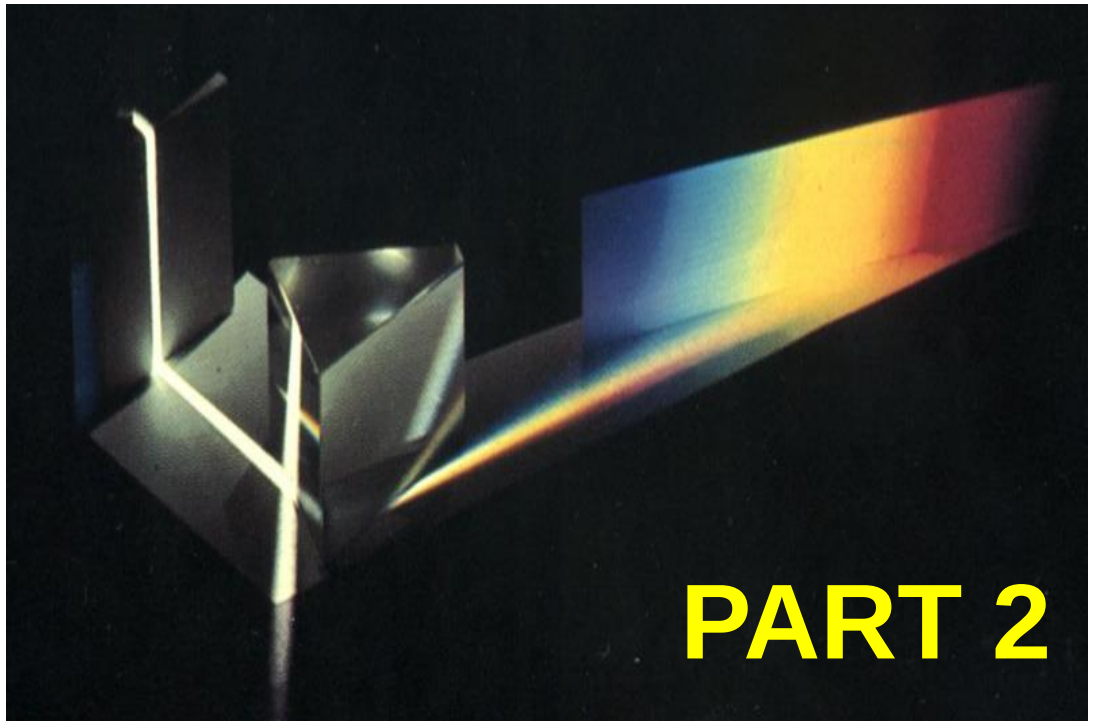
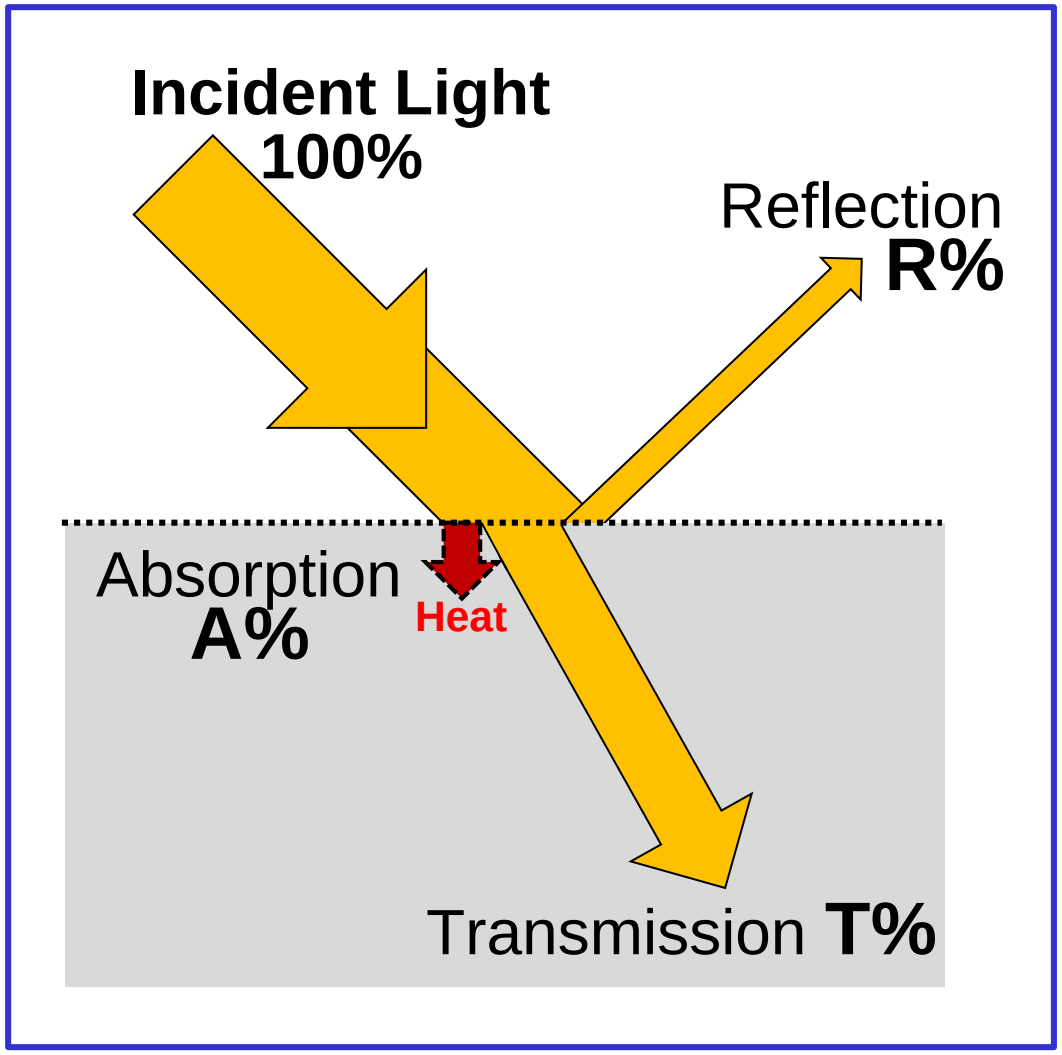
Light meets Matter



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.**

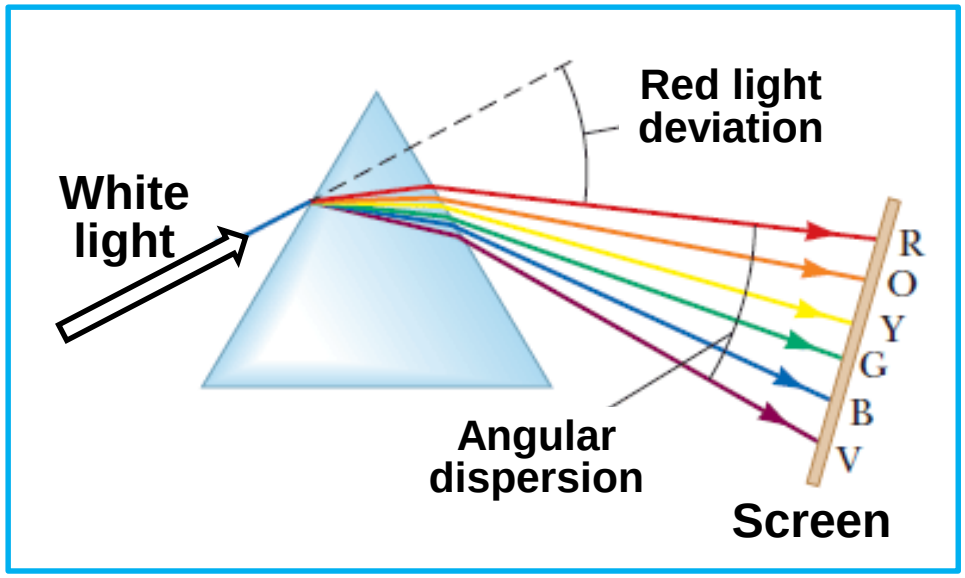
Dispersion of Light

splitting of light into its component colors

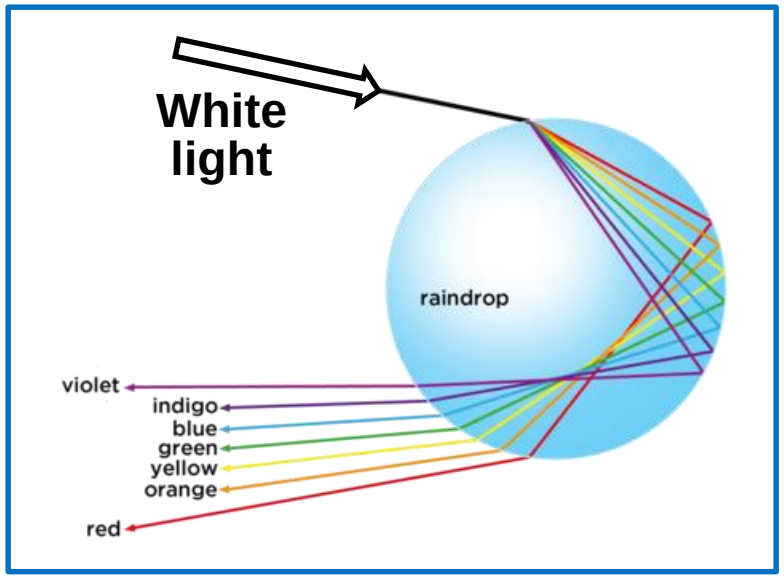
Different colors (wavelengths) of light *travel at different speed in the same material* and therefore refract differently:

- **Red (longer wavelength) is bent less.**
- **Violet (shorter wavelength) is bent more.**
- **This allows for separation of colors in certain geometries.**

Glass prism



Water droplet



Rainbow

Rainbows result from refraction of sunlight in falling water droplets plus reflection of the light from the back of the droplet.

The size of the droplets influences the rainbow appearance: large droplets (>1mm) result in lack of blue color, small droplets make red disappear; fine mist and fog (<0.05mm) produce white or "fog" bow.

Rainbows…in your backyard!

All you need is small water droplets and bright sunlight!

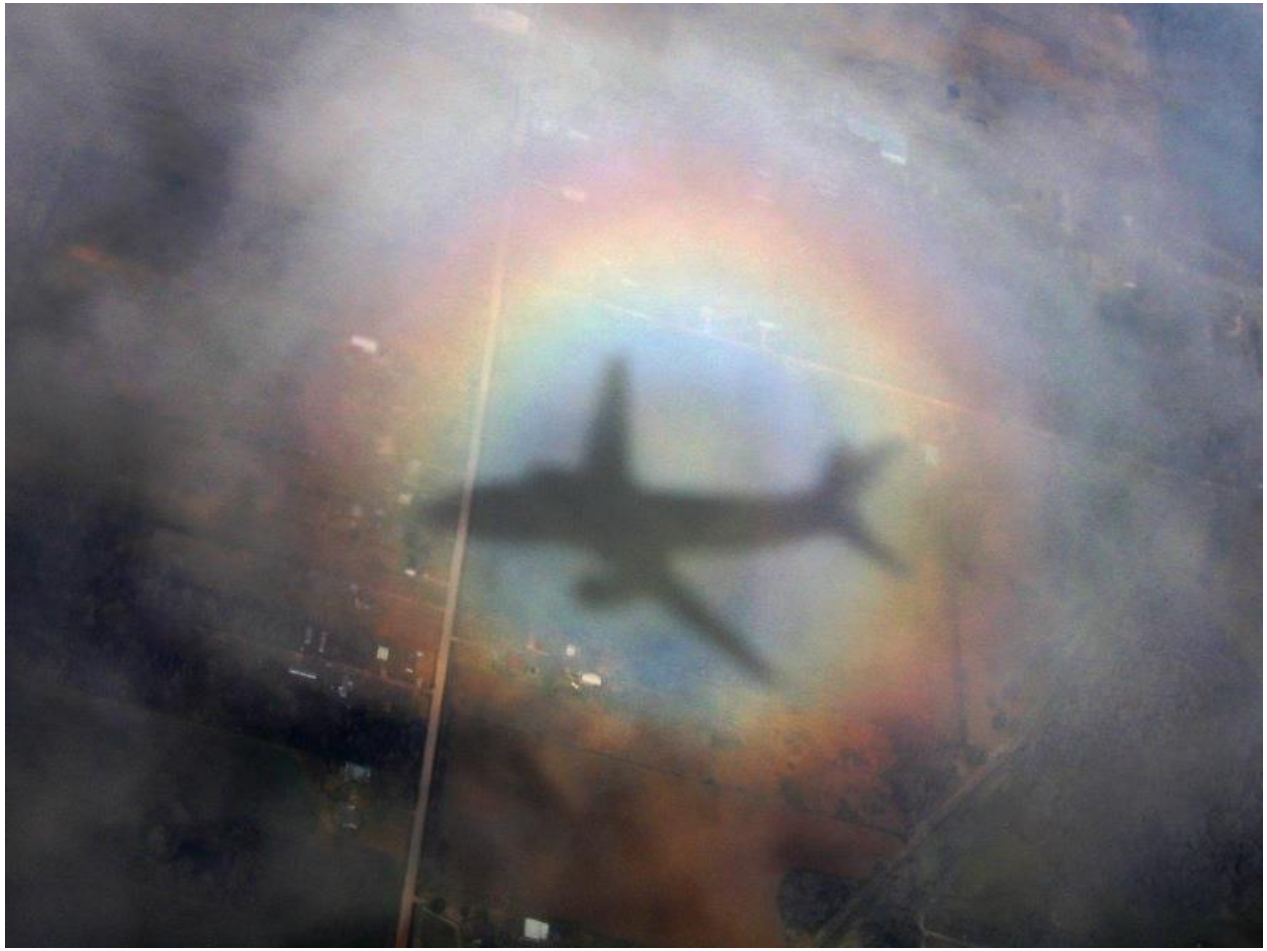
Can you see the rainbow when the **Sun is overhead**?

Can you see the **full circle**?

Think again ☺

The Glory

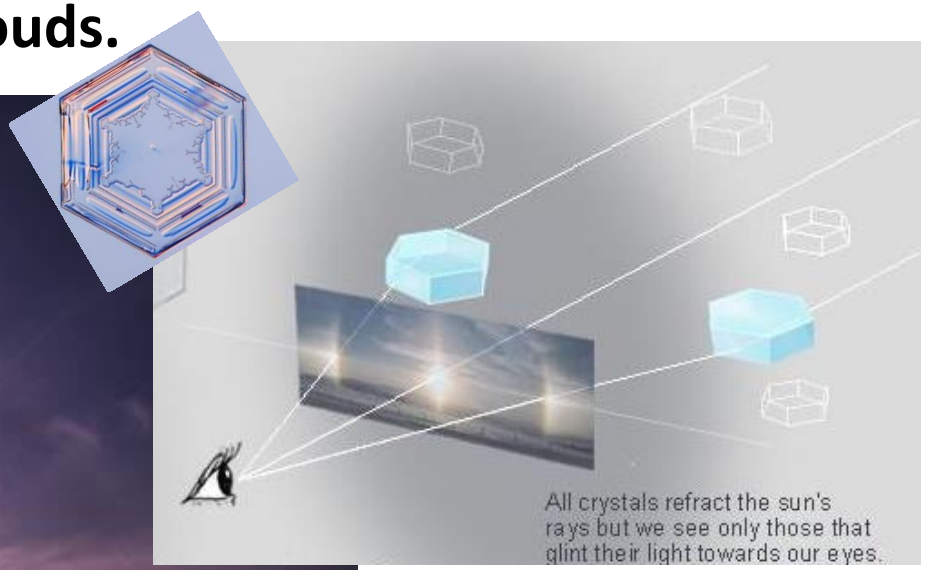
All you need to do is position yourself between the Sun and the raincloud!



What happens to light if we have ice crystals in the air instead of water droplets?

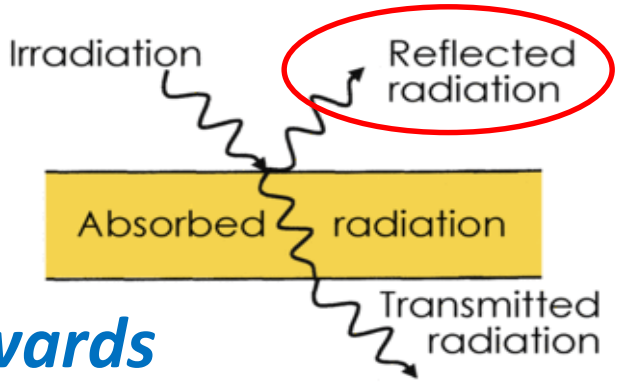
The Sun Halo and the Sun Dogs

formed by light refraction in horizontally floating hexagonal plate ice crystals high in the cirrus clouds.

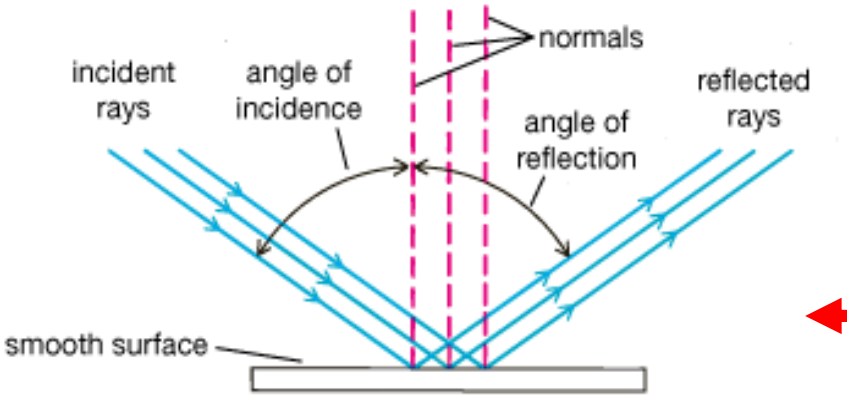


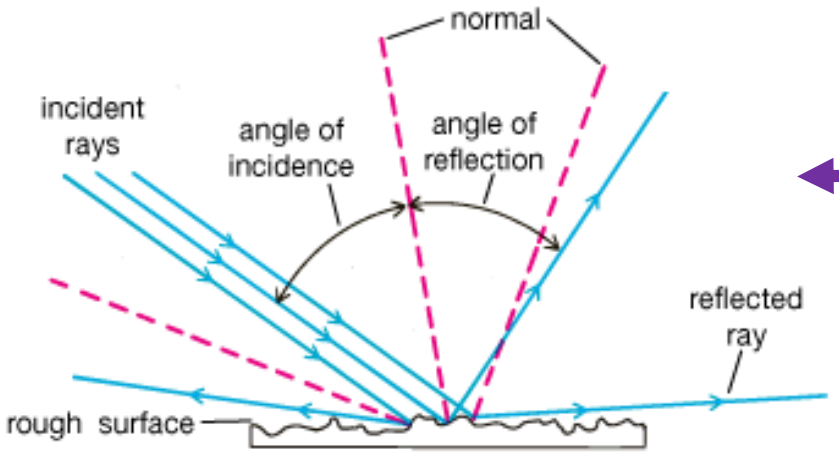
The Sun Halo and the Sun Dogs occur world-wide but more common in cold climates.

Reflection



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





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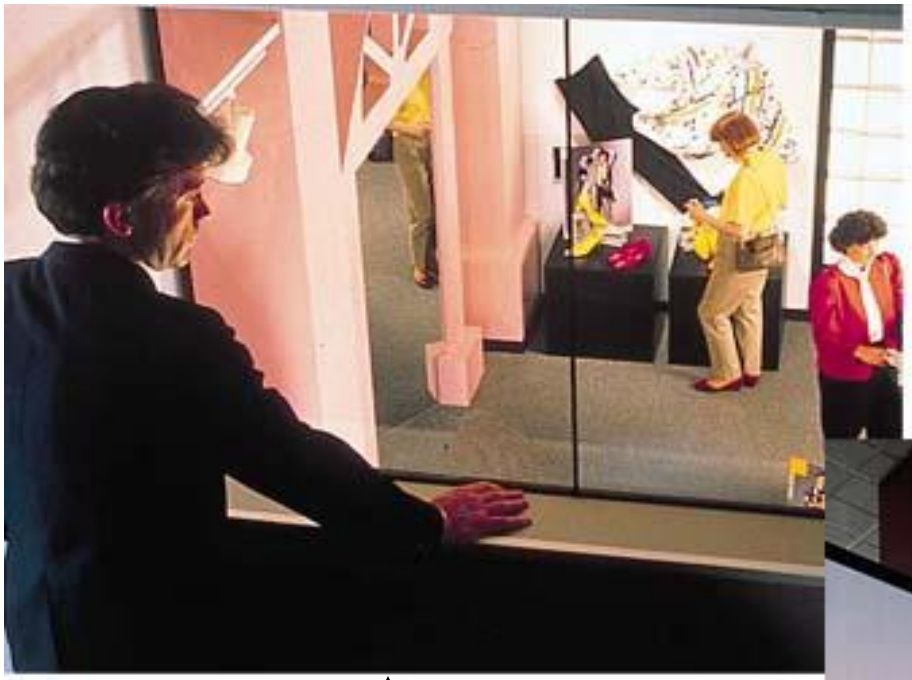
- **Reflection is <u>re-radiation of light by the electrons</u> in the reflecting material.**

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 irregularities.

One-way Mirror
(reflection+transmission)

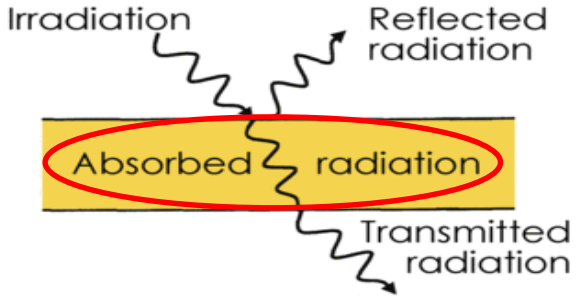


A one-way mirror reflects most of the light that strikes its surface

It also transmits some light to a person behind the mirror in a darkened room.

Absorption

disappearance of a photon

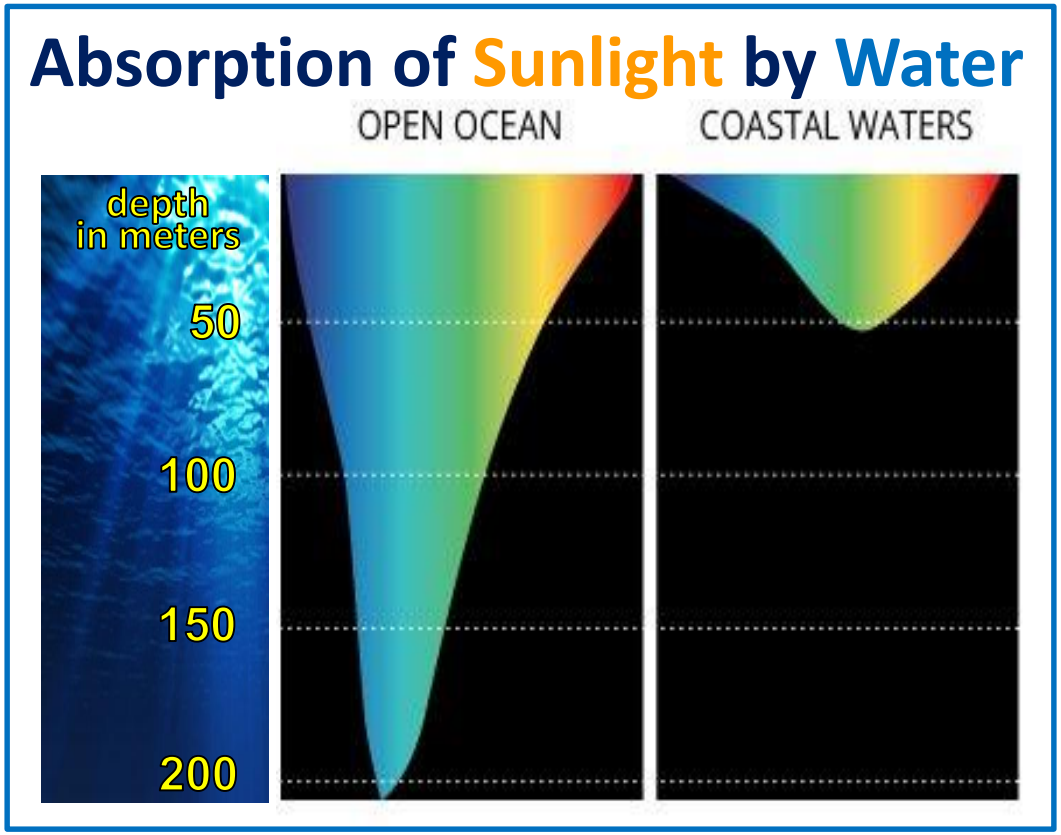


- **Absorption of electromagnetic radiation is the process in which the energy of a photon is taken up by matter, typically the electrons of an atom.**

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

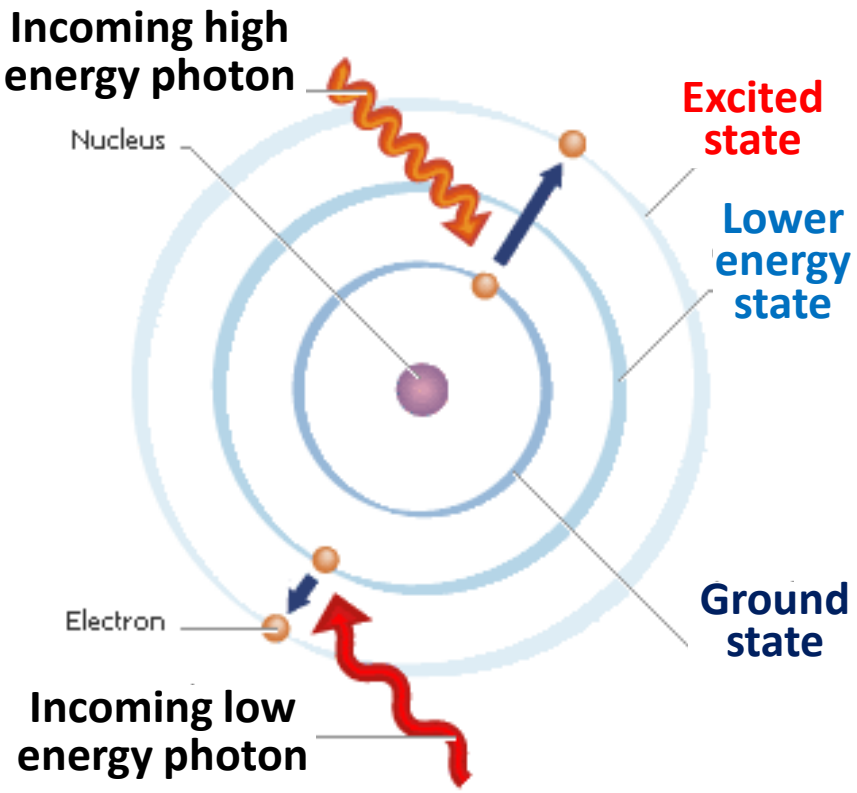
- **Dark opaque objects absorb most of the incident light.**

- **In most cases, energy of the absorbed photon is converted to *heat*.**



Absorption Spectrum

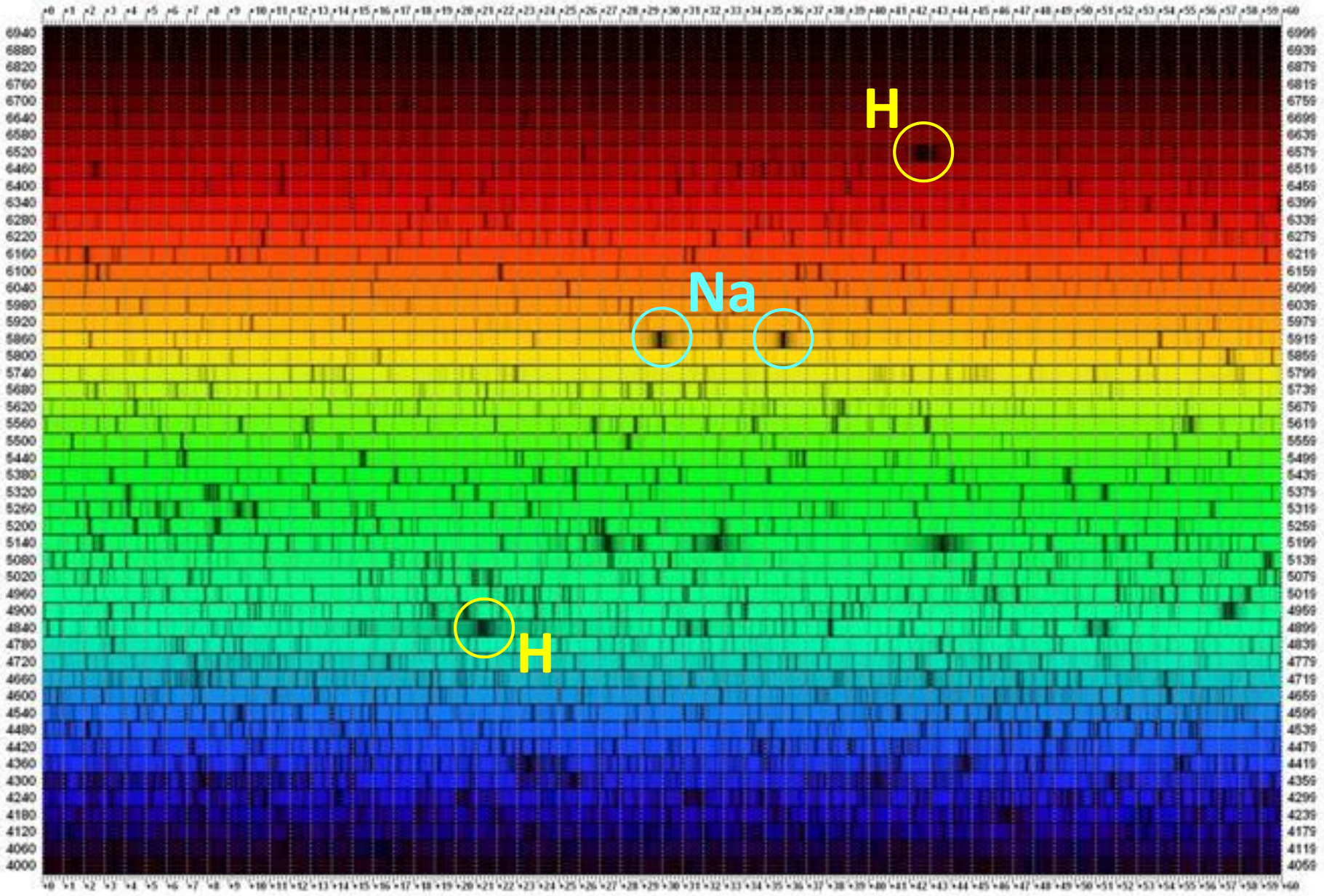
Absorption of light can happen when the photon energy (i.e. *frequency*) matches one of the allowed transitions between energy levels of that particular atom.



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.