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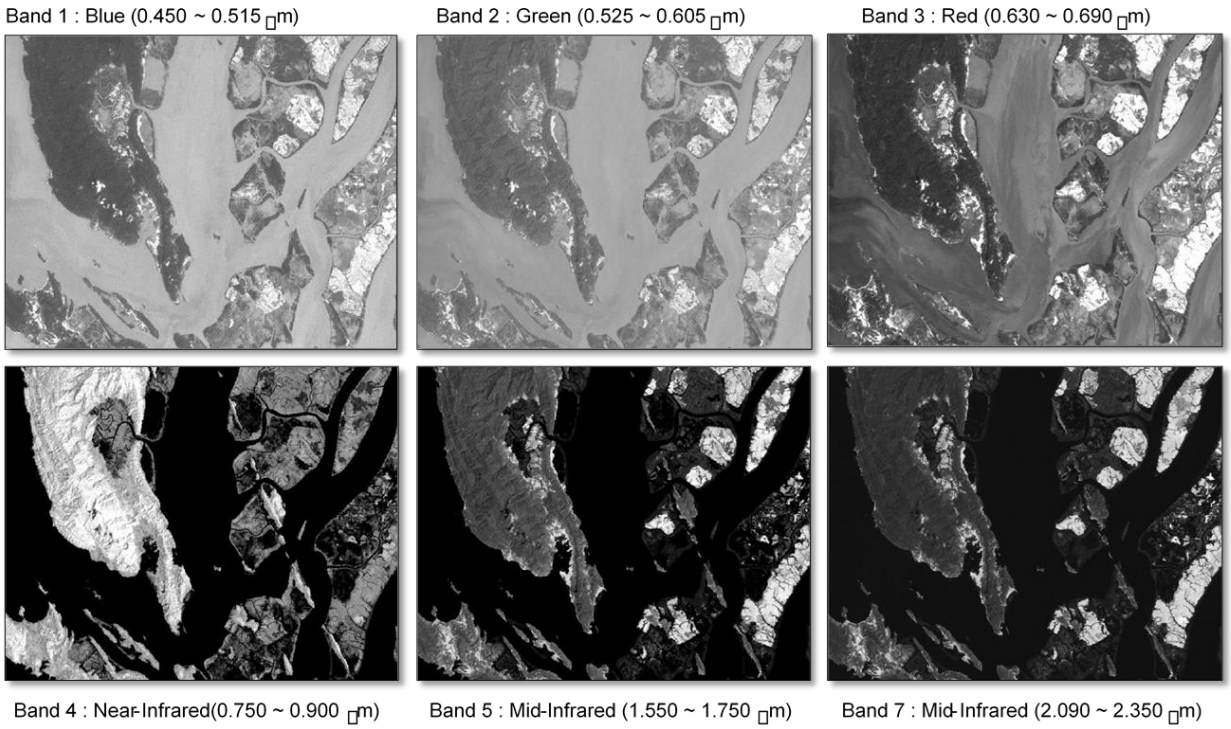
## Multi-spectral Remote Sensing Data (Image) (Continued)

Example in Landsat TM/ETM (Band 6 omitted)

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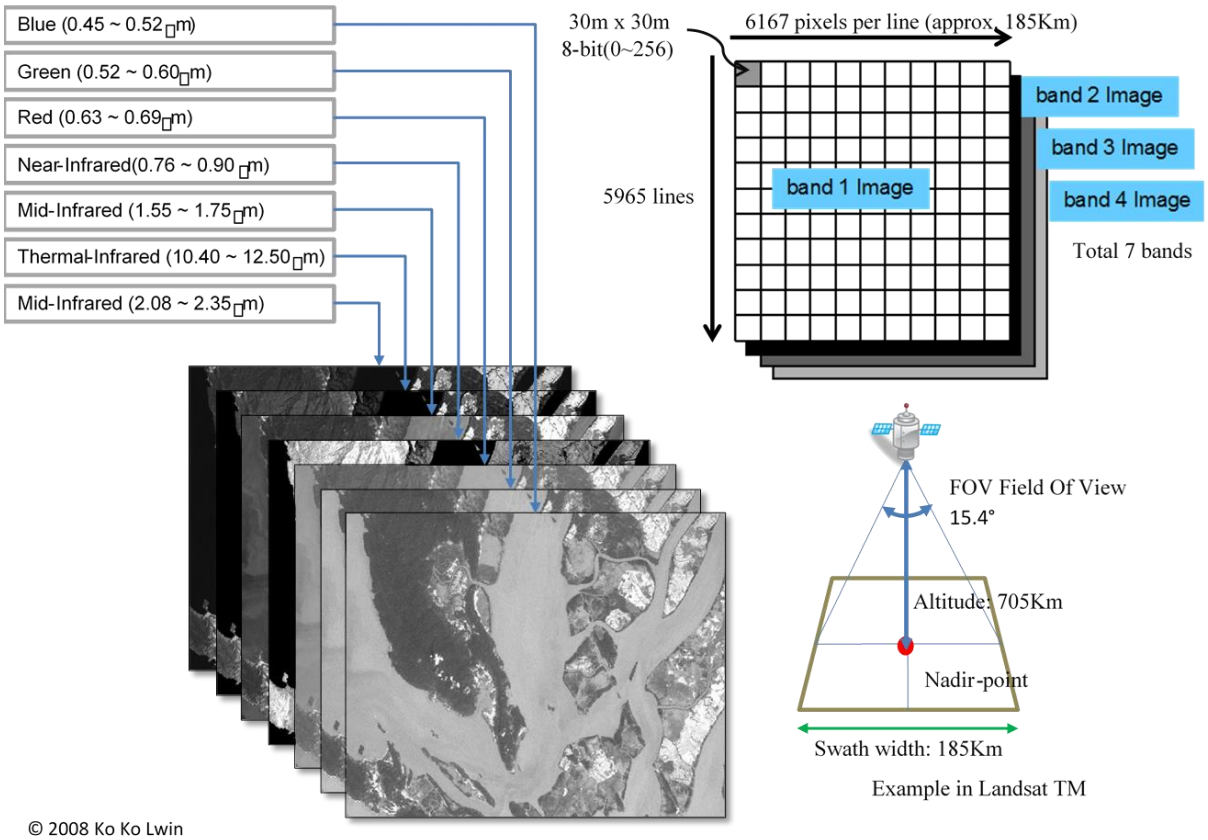
## Structure of Remote Sensing Data (*Example in Landsat TM*)

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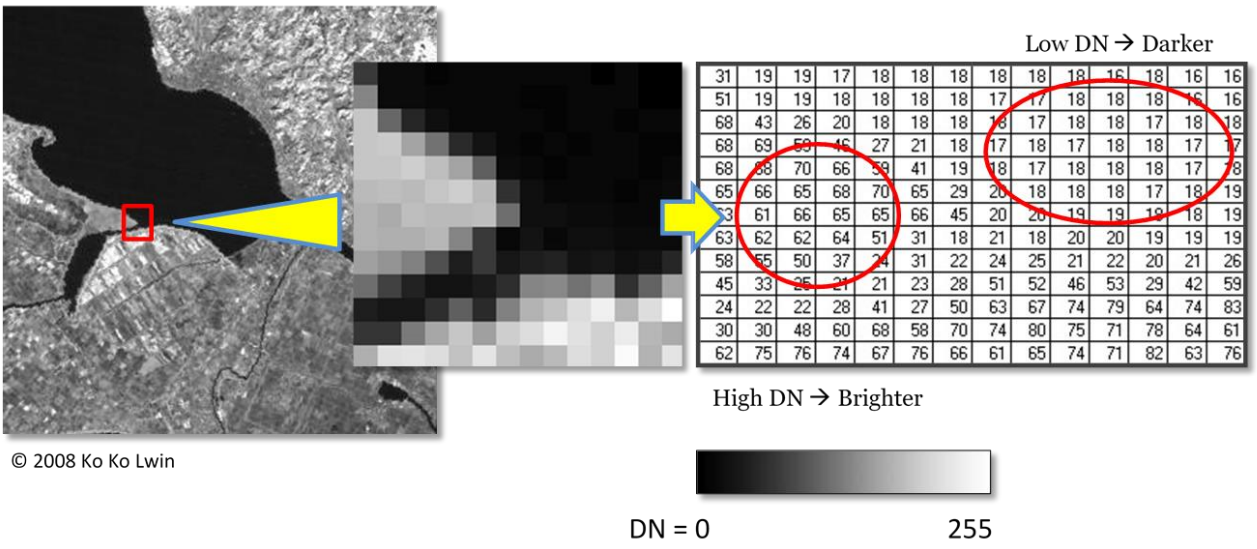
# Spectral Properties and Principal Applications
# Example in Landsat TM/ETM

| Band | Wavelength (μm) | Principal applications |
|---|---|---|
| B-1 | 0.45 - 0.52 (Blue) | This band is useful for mapping coastal water areas, differentiating between soil and vegetation, forest type mapping, and detecting cultural features. |
| B-2 | 0.52 - 0.60 (Green) | This band corresponds to the green reflectance of healthy vegetation. Also useful for cultural feature identification. |
| B-3 | 0.63 - 0.69 (Red) | This band is useful for discriminating between many plant species. It is also useful for determining soil boundary and geological boundary delineations as well as cultural features. |
| B-4 | 0.76 - 0.90 (Near-Infrared) | This band is especially responsive to the amount of vegetation biomass present in a scene. It is useful for crop identification and emphasizes soil/crop and land/water contrasts. |
| B-5 | 1.55 - 1.75 (Mid-Infrared ) | This band is sensitive to the amount of water in plants, which is useful in crop drought studies and in plant health analyses. This is also one of the few bands that can be used to discriminate between clouds, snow, and ice. |
| B-6 | 10.4 - 12.5 (Thermal Infrared) | This band is useful for vegetation and crop stress detection, heat intensity, insecticide applications, and for locating thermal pollution. It can also be used to locate geothermal activity. |
| B-7 | 2.08 - 2.35 (Mid-Infrared) | This band is important for the discrimination of geologic rock type and soil boundaries, as well as soil and vegetation moisture content. |

## Spectral Reflectance to DN (Digital Number)

In fact, remote sensing data is converting of spectral reflectance value to digital number (DN) known as a pixel. Each spectral wavelength represents as a single layer in remote sensing data called "Band" or "Channel". The more bands or channels present, the more spectral properties in remote sensing data.

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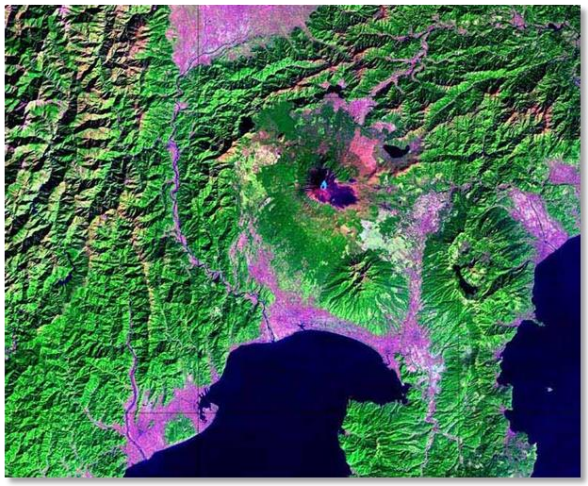
## Resolutions in Remote Sensing

There are four types of resolutions in Remote Sensing.

**(a) Spatial Resolution**: The detail discernible in an image is dependent on the spatial resolution of the sensor and refers to the size of the smallest possible feature that can be detected.

Example: Landsat TM Spatial resolution 30mx30m, QuickBird 67cm x 67cm



Landsat TM 30m x 30m

QuickBird 67cm x 67cm

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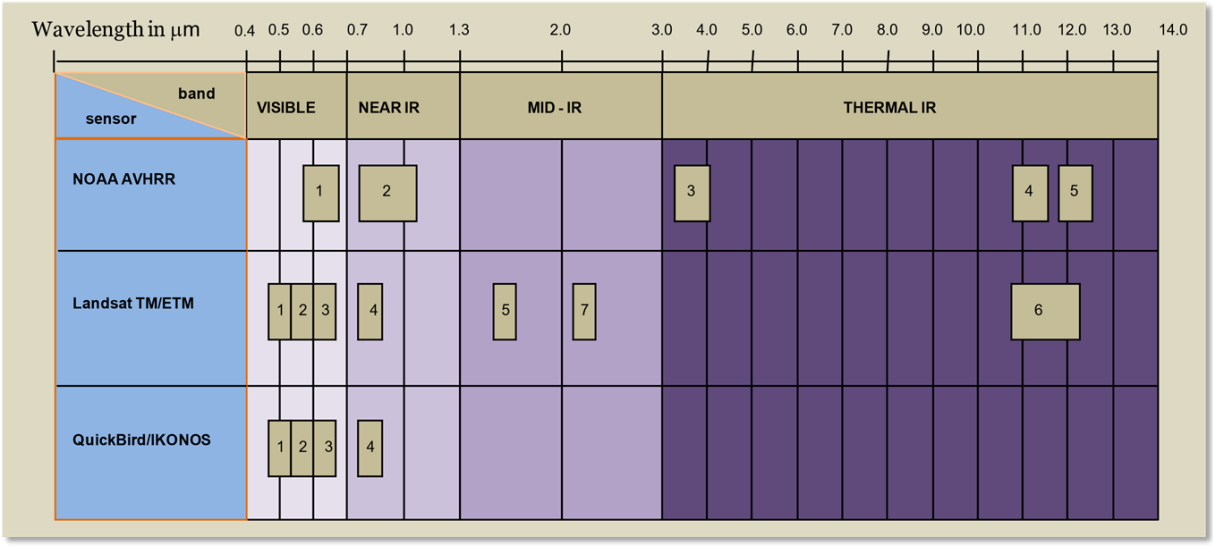
**(b) Spectral Resolution**: Spectral resolution describes the ability of a sensor to define fine wavelength intervals. The finer the spectral resolution, the narrower the wavelength range for a particular channel or band.

Example: Landsat TM has 7 Bands, QuickBird/IKONOS Multispectral has 4 Bands, etc.



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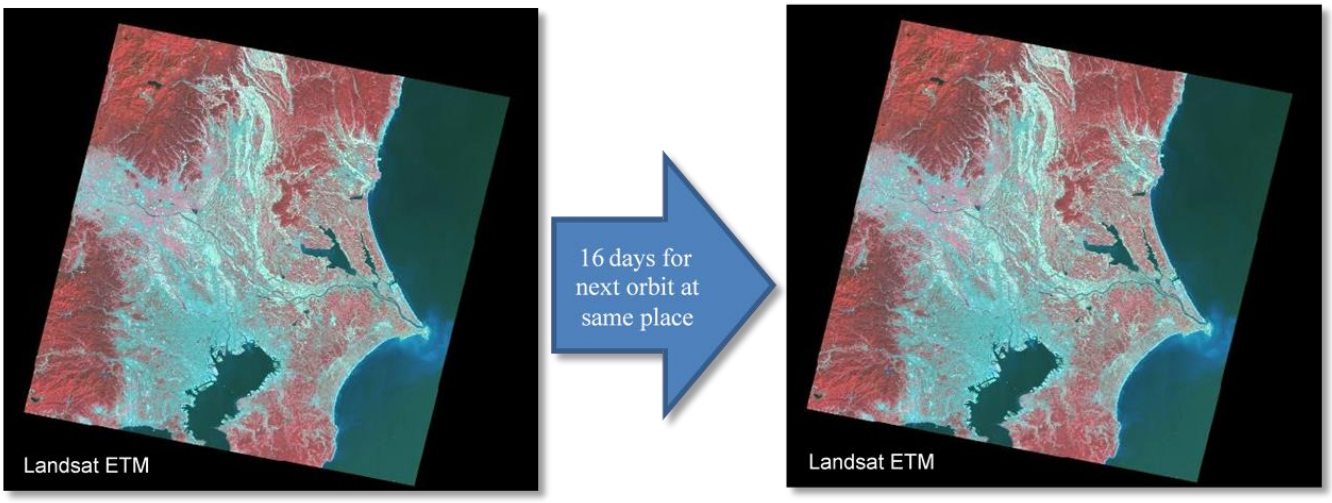
**(c) Temporal Resolution**: Also important to consider in a remote sensing system, refers to the length of time it takes for a satellite to complete one entire orbit cycle. The revisit period of a satellite sensor is usually several days except Geostationary satellites.

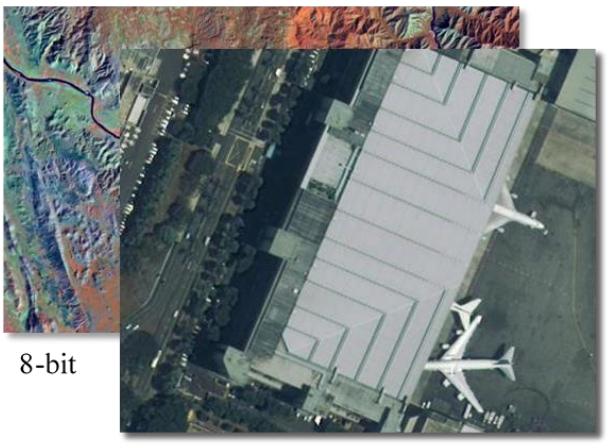
Example: Landsat TM 16 days, SPOT 26 days, etc.



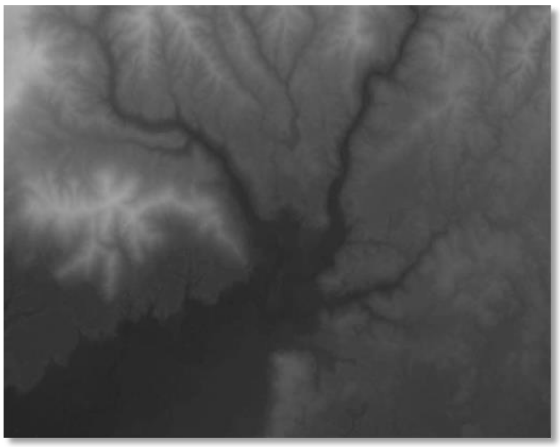

**(d) Radiometric Resolution**: The radiometric resolution of an imaging system describes its ability to discriminate very slight differences in energy.
The finer the radiometric resolution of a sensor, the more sensitive it is to detecting small differences in reflected or emitted energy.

Example: Landsat TM 8 bits, SPOT 8 bits, IKONOS 11 bits. However, most computer programs do not support 11-bit, so it will convert to 16-bit.

8-bit : $2^8$ = maximum 256 color levels or DN values (commonly used)
16-bit : $2^{16}$ = maximum 65536 color levels or DN values (especially used in elevation data, e.g. DEM, DSM, DTM, etc.)



8-bit



16-bit

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## Types of Remote Sensing

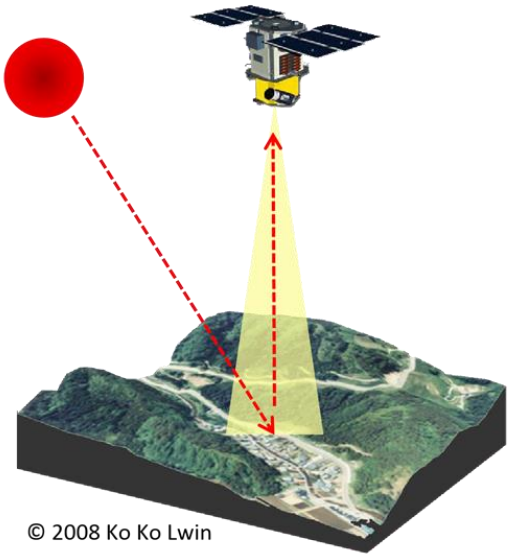
Passive Remote Sensing and Active Remote Sensing

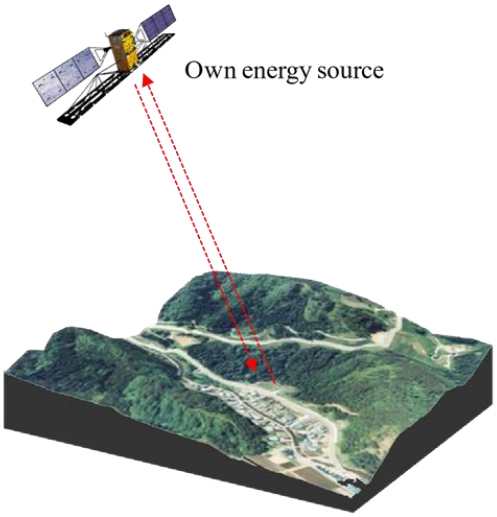
**Passive Remote Sensing**

Remote sensing of energy naturally reflected or radiated from the terrain.

**Active Remote Sensing**

Remote sensing methods that provide their own source of electromagnetic radiation to illuminate the terrain. Radar is one example.




## Active and Passive Remote Sensing

Passive sensors have no on-board source of EMR.

Usually operate in the naturally-abundant visible and infrared portions of the spectrum.

Active sensors carry their own source of EMR.

Usually operate in low-energy or naturally-scarce regions of the spectrum.

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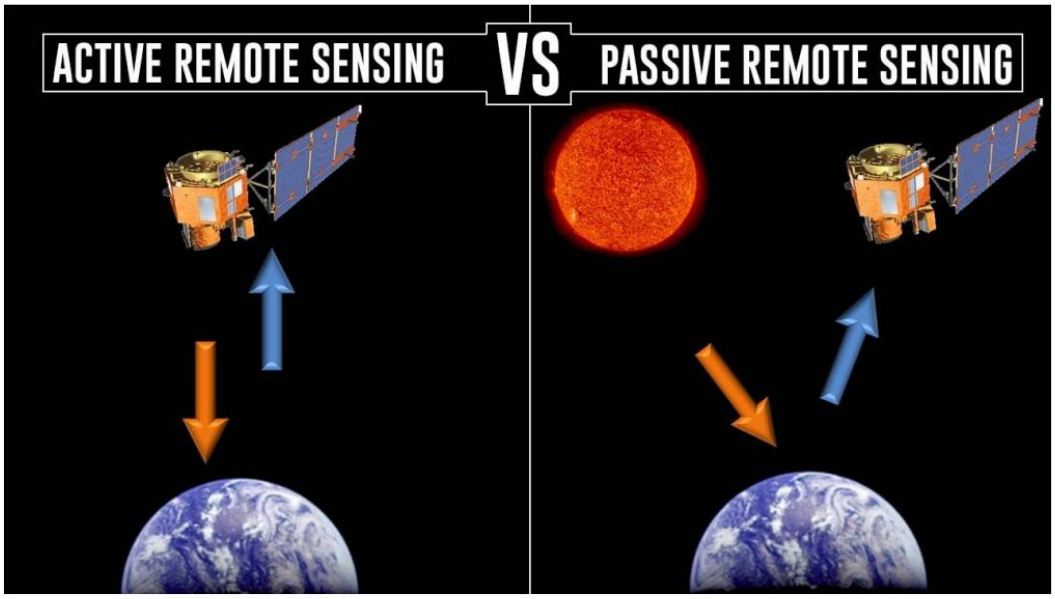
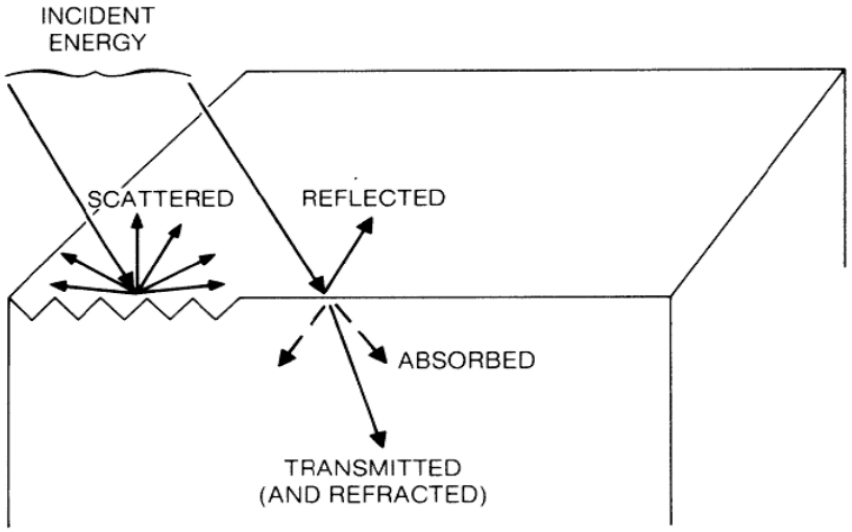



# Interaction between EMR and Matter




## Reflectance

Re-radiation of photons in unison, in a layer approximately ½ wavelength deep.

- 'Bouncing off' a surface

In the atmosphere, clouds reflect a significant amount if incident radiation.

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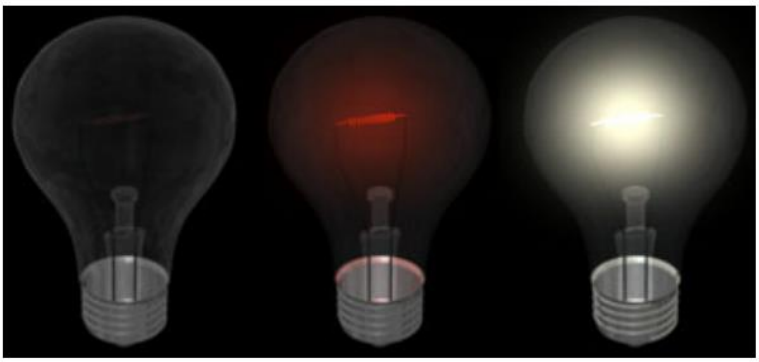
# Radiation Intensity vs Temperature



24°C 677°C 2200°C

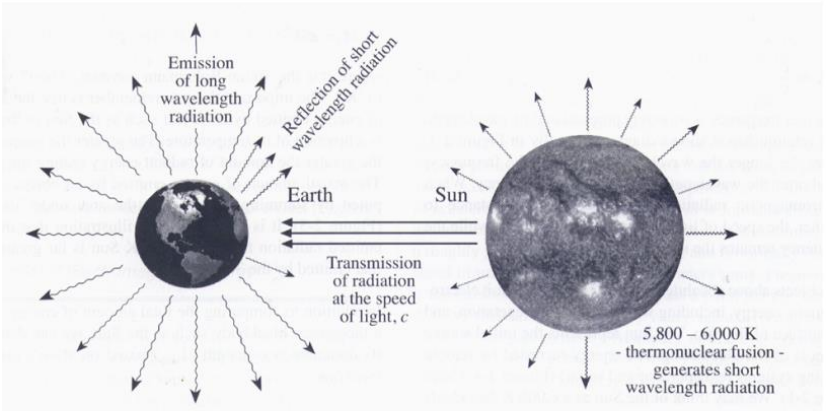
**Higher Temperature**

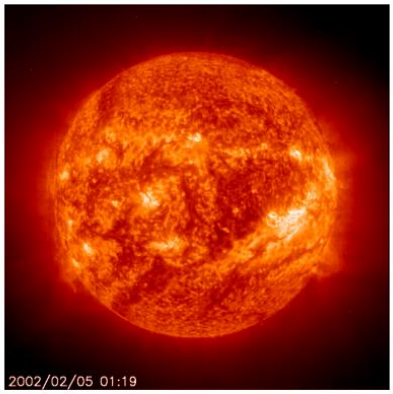
⇩

**Higher intensity of Radiation**

⇩

**Smaller wavelength**




# Scattering

**Operates through absorption and re-radiation of radiation by atoms or molecules.**

When scattering occurs in a volume (as in the atmosphere), we specify three types:

1. Mie
2. Raleigh
3. Non-selective

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# Mie Scattering

Occurs when particles are approximately same size as wavelength.

Caused by dust, smoke, particulates in lower atmosphere

# Rayleigh Scattering

- Occurs when the particle are smaller (usually < 0.1 times) than the wavelength.
- Caused mainly by gases in upper atmosphere
  - Molecular scattering from Oxygen and Nitrogen

Act

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# Non-selective Scattering

- Occurs with particles many times greater in size than wavelength.
- Caused by water droplets, ice crystals in lower atmosphere.
- Non-selective with respect to visible wavelengths.