SPECTRAL REFLECTANCE CURVES

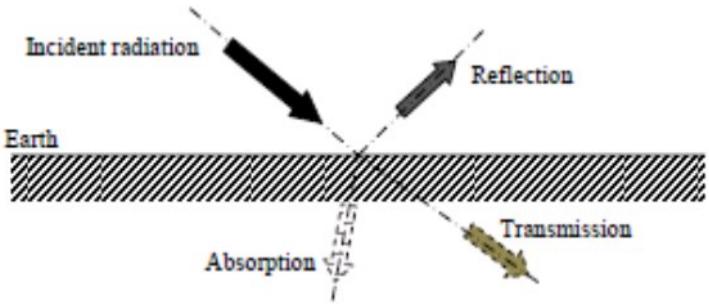
Energy Interactions (continued…)

As we have studied, energy incident on the Earth's surface is absorbed, transmitted or reflected depending on the wavelength, and characteristics of the surface features (soil, vegetation or water body).

These three processes are not mutually exclusive. Energy incident on a surface may be partially reflected, absorbed or transmitted. Which process takes place on a surface depends on the following factors:

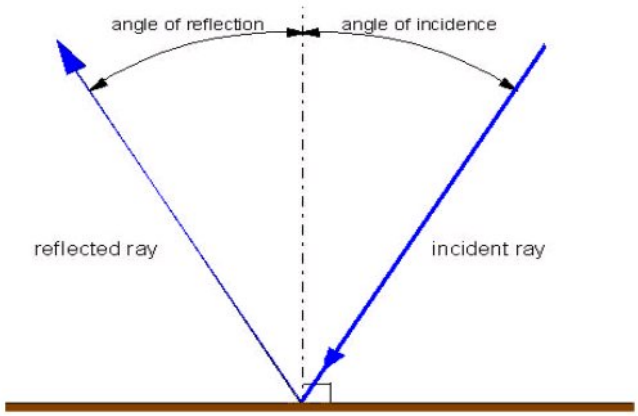
- Wavelength of the radiation
- the characteristics of the incident radiation
- Angle at which the radiation intersects the surface
- Composition and physical properties of the surface

After interaction with the surface features, energy that is reflected or re-emitted from the features is recorded at the sensors and are analysed to identify the target features, interpret their characteristics.

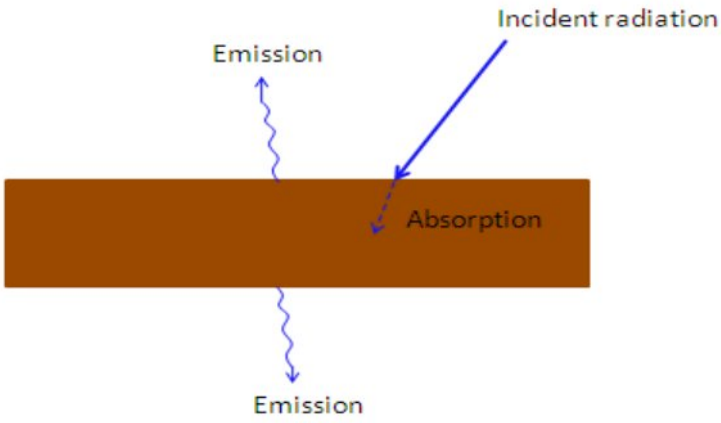


The incident electromagnetic energy may interact with the earth surface features in three possible ways: Reflection, Absorption and Transmission.

- Reflection occurs when radiation is redirected after hitting the target. According to the law of reflection, the angle of incidence is equal to the angle of reflection.



- Transmission occurs when radiation is allowed to pass through the target. Depending upon the characteristics of the medium, during the transmission velocity and wavelength of the radiation changes, whereas the frequency remains same. The transmitted energy may further get scattered and / or absorbed in the medium.
- Absorption occurs when radiation is absorbed by the target. The portion of the EM energy which is absorbed by the Earth's surface is available for emission and as thermal radiation at longer wavelengths. (Therefore, sometimes *Absorbance* in energy balance equation can be represented as emissivity.)



So, the energy balance equation becomes,

$$E_R(\lambda) = E_I(\lambda) - E_A(\lambda) - E_T(\lambda)$$

Dividing by $E_I(\lambda)$,

$$\frac{ER(\lambda)}{EI(\lambda)} = 1 - \{ \frac{EA(\lambda)}{EI(\lambda)} + \frac{ET(\lambda)}{EI(\lambda)} \}$$

$$Reflectance = 1 - (Absorbance + Transmittance)$$

$\because$ All the objects on earth are opaque in nature, $\therefore$ *Transmittance* = 0 (neglected).

Now, $$Reflectance = 1 - (Absorbance)$$

Or

$$Reflectance = 1 - (Emissivity)$$

If absorbance =1, reflectance=0 implies that total energy incident is completely absorbed by the object. Black body such as lamp smoke is an example of this type of object.

If absorbance =0, reflectance=1 implies that total energy incident is reflected and recorded by the sensing system. The classic example of this type is Snow (i.e. White object).

Spectral Reflectance

The reflectance characteristics of earth surface features expressed as the ratio of energy reflected by the surface to the energy incident on the surface, measured as a function of wavelength is called spectral reflectance, R_λ. It is also known as albedo of the surface. It may vary from 0-100%.

$$\text{Spectral reflectance} = \frac{ER(\lambda)}{EI\ (\lambda)}$$

$$= \frac{\text{Energy of wavelength } \lambda \text{ reflected from the object}}{\text{Energy of wavelength } \lambda \text{ incident on the object}} \times 100$$

Spectral Reflectance/radiance of various Earth surface features is as follows

Surface type	Albedo %
Grass	25
Concrete	20
Water	5-70
Fresh snow	80
Forest	5-10
Thick cloud	75
Dark soil	5-10

Reflectance/radiance of fresh snow is generally very high. Dry snow reflects almost 80% of the energy incident on it. Clouds also reflect a majority of the incident energy. Dark soil and concrete generally show very low albedo. Reflectance of vegetation is also generally low, but varies with the canopy density. Albedo of forest areas with good canopy cover is as low as 5-10%. Reflectance of water ranges from 5 to 70%. Reflectance is low at lower incidence angle and increases for higher incidence angles.

The energy that is reflected by features on the earth's surface over a variety of different wavelengths will give their spectral responses in the remote sensing systems. Each type of feature/object has a unique spectral response/ reflectance characteristics, also known as *spectral signature*, which can be used to identify the respective surface features & to study their properties.