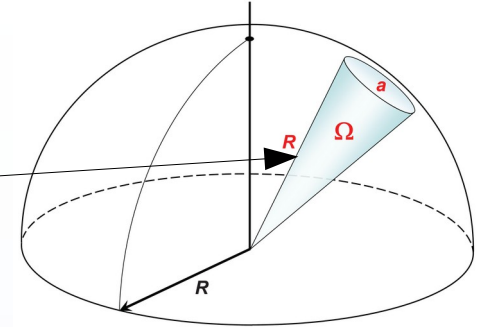


EGM310 – Remote Sensing and GIS

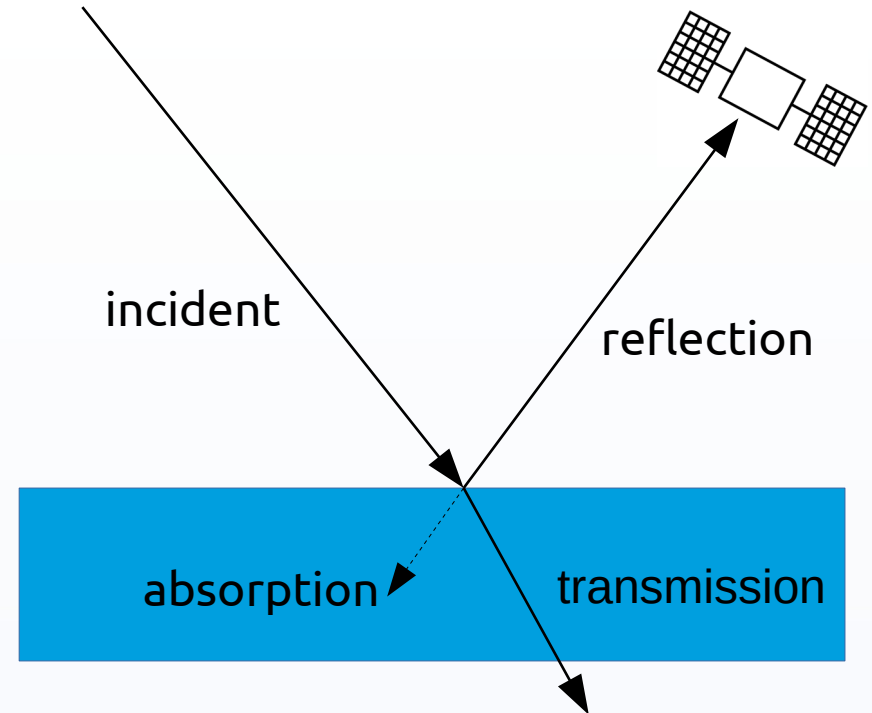
Week 9, Part 4: Interaction with Earth's surface

Some definitions

- **Radiant energy** (Q , [J]): the amount of energy
- **Radiant flux** (Φ , [W] [J s^{-1}]): energy per unit time
- **Radiant intensity** (I , [W sr^{-1}]): radiant flux per solid angle
- **Radiance** (L , [$\text{W sr}^{-1} \text{m}^{-2}$]): flux per solid angle per area
- **Radiant emittance** (M , [W m^{-2}]): radiant flux emitted from surface
- **Irradiance**, (E , [W m^{-2}]): radiant flux onto a surface
- **Radiosity** (J , [W m^{-2}]): radiant flux leaving a surface (emitted, reflected, transmitted)
- **Spectral radiance** (L_λ , [$\text{W sr}^{-1} \text{m}^{-3}$]): Radiance per wavelength unit
- **Spectral irradiance** (E_λ , [W m^{-3}]): Irradiance per wavelength unit



- EMR interacts with Earth surface similar to atmosphere:
 - Reflection
 - Absorption
 - Transmission
- How, and how much, depends on:
 - Properties of surface
 - Wavelength
 - Angle of illumination (incidence)



$$\Phi_i = \Phi_r + \Phi_a + \Phi_t$$

- For visible/infrared, usually what we measure with our sensor
- Two main kinds of reflectant surfaces:
 - Specular (mirror-like)
 - Diffuse
- Can also define reflectance:

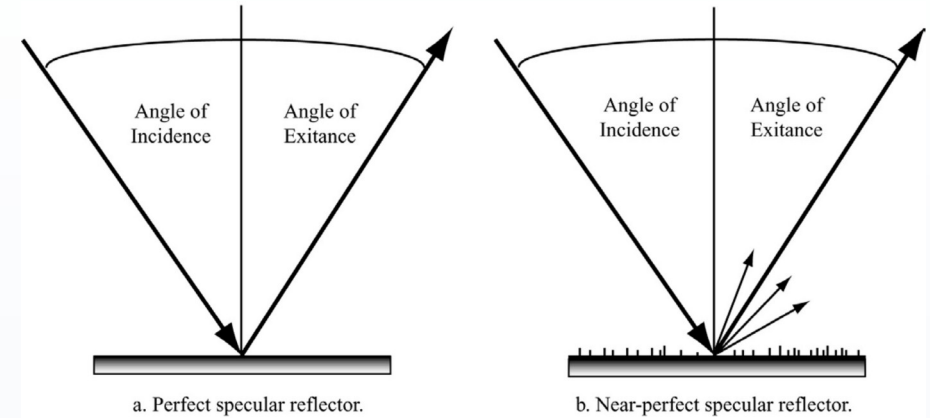
$$\rho = \frac{E_r}{E_i}$$

E_r ← Energy reflected by surface
 E_i ← Energy incident on surface



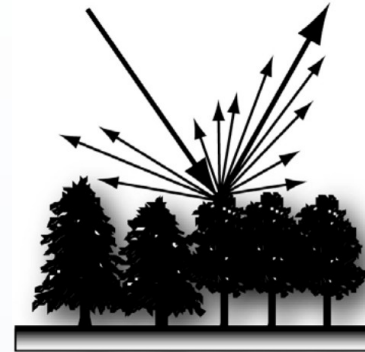
Specular reflectors

- Smooth (relative to λ) surfaces
- Redirects all (or nearly all) incident radiation in a single direction
- Angle of incidence equals angle of reflection

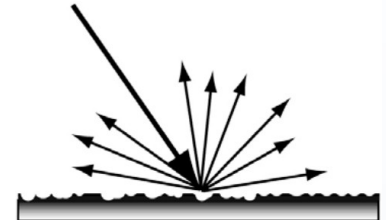


Diffuse Reflectors

- Rough surface (relative to λ)
 - Energy scatters (almost) uniformly in all directions
 - Diffuse reflection contains spectral information on the “colour” of the reflecting surface
- ⇒ Most often, diffuse reflection is the **most useful** in remote sensing



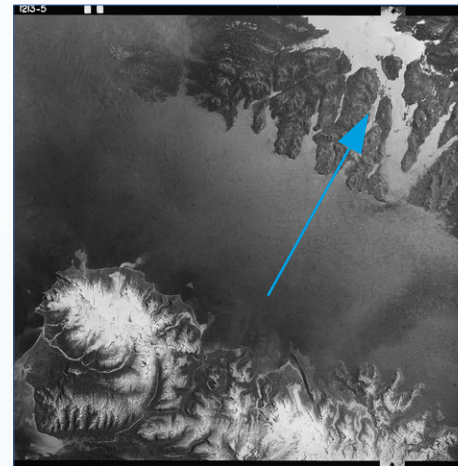
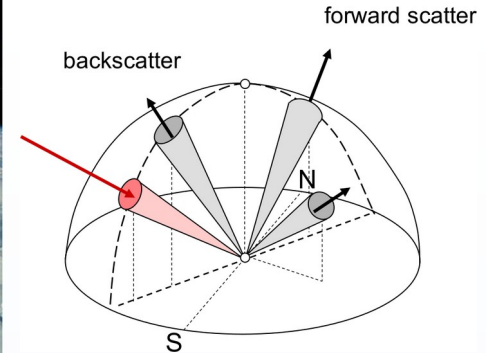
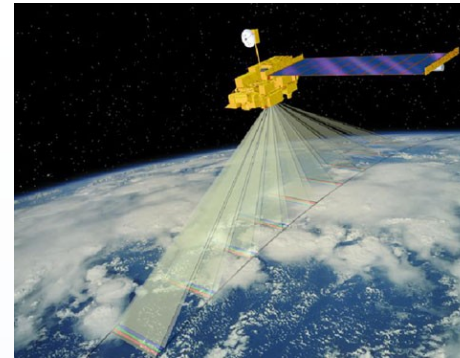
c. Near-perfect diffuse reflector.



d. Perfect diffuse reflector, or Lambertian surface.

Bidirectional Reflectance Distribution Function

- Most surfaces lie somewhere between the ideals
- Behaviour (specular/diffuse reflector) often depends on viewing angle
- **Bidirectional reflectance distribution function** (BRDF) is a way to describe/assess this
- We can use BRDF of a surface to estimate **albedo** (ratio of radiosity to irradiance)
- Need multiple viewing angles of surface



Absorption & Transmission

- Energy that isn't reflected is either absorbed or transmitted
- Properties of surface determine how, at what wavelengths
- Examples:
 - Most (healthy) plant leaves appear green (absorption of red, blue)
 - Water color changes with depth (absorption of longer wavelengths, transmission, sediment/particles)



- EMR that makes it through the atmosphere interacts with Earth's surface
 - Either reflected, absorbed, transmitted
- Reflection is (usually) what we measure in remote sensing
 - Depends on wavelength, viewing/illumination angle, surface properties
- Of these, the most useful is generally diffuse reflection

- Lillesand, Kiefer & Chipman – Chapter 1
- Campbell & Wynne – Chapter 2
- Natural Resources Canada [Remote Sensing Tutorials](#)
- Light Absorption, Reflection and Transmission
[[Bozeman Science](#)]
- Specular Reflection [[Bozeman Science](#)]
- Specular and Diffuse Reflection [[Khan Academy](#)]