REMOTE SENSING

GEE 3622

Basic Introduction

Definition

- Science and art of obtaining information about an object, area or phenomenon through the analysis of data acquired by a devise that is not in contact with the object, area or phenomenon (Lillesand).

Data related to earth can be collected from

1. Ground
2. Above the ground
3. in air
4. space

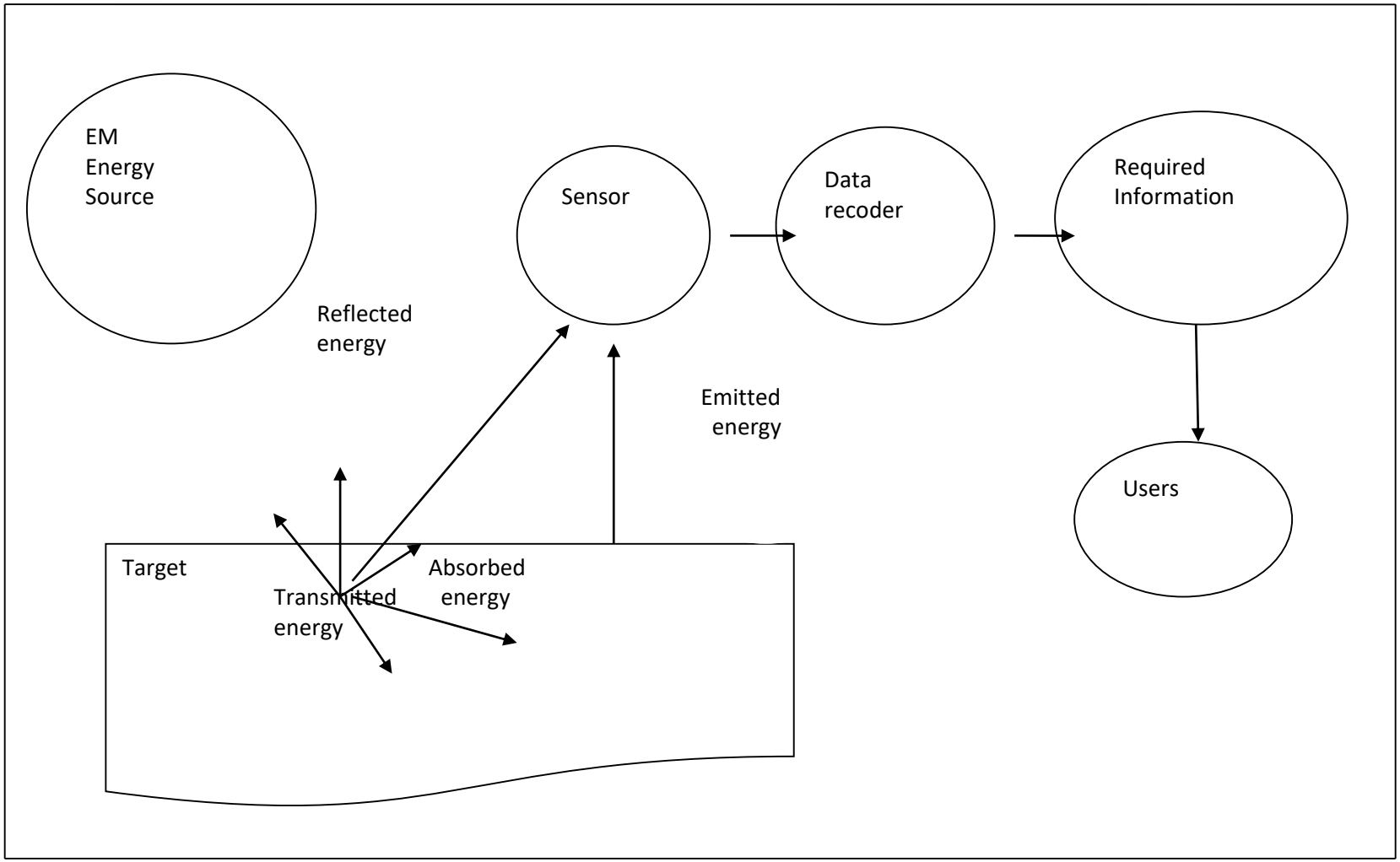
- Data collected in air by camera, process is called aerial photogrammetry
- Same data collected through sensor mounted on satellite, process is remote sensing

REMOTE SENSING

- It involves interpretation of Electromagnetic energy reflected from or emitted by a target from a vantage point that is distant from the target.

- Detection and recording instruments used include photographic cameras, mechanical scanners, and radar systems.

The Ideal RS system



The Real RS system

- Gases, water vapour and dust particles present in the atmosphere interact with energy leading to modification of strength and spectral distribution
- Same matter under different conditions may have different spectral response
- Also different matters may have similar spectral response

Remote Sensor Systems

Passive Remote – detect only reflected sunlight or thermal IR and microwaves

- Photograph camera
- Electro-optical
- Passive microwave

Active Remote – beam own artificially produced energy to a target and record reflected component

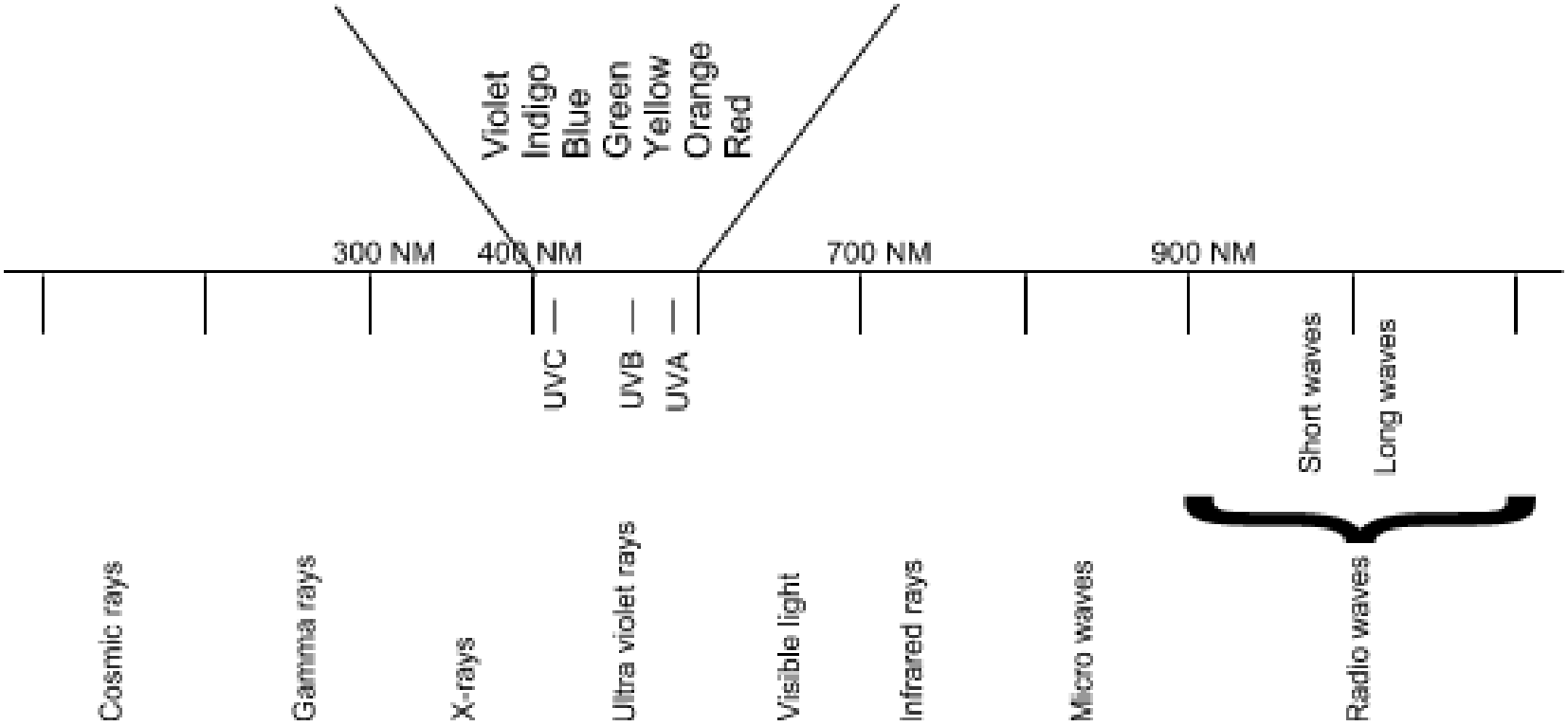
Radar

Sonar

Electromagnetic Radiation

- RS relies on measuremet of EM energy
- EM nergy can take several different forms
- One important source of energy is the sun which provides energy at all wavelength

Electromagnetic Energy



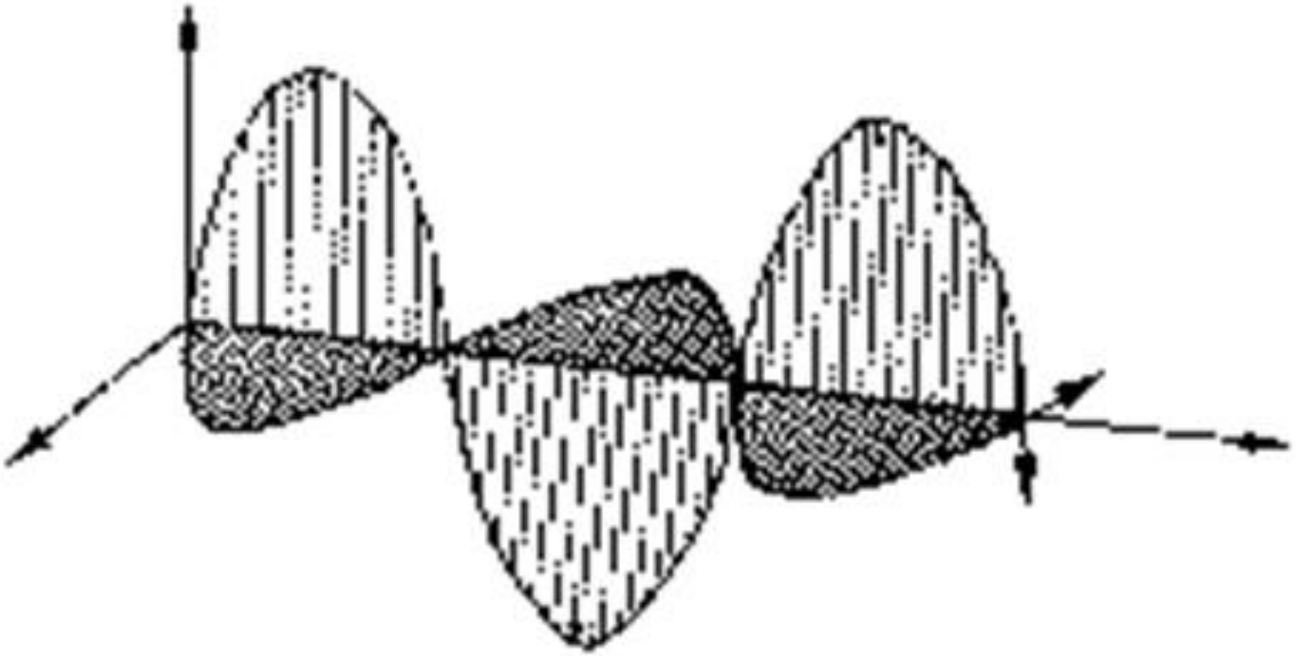
Electromagnetic Energy

- Can be modelled by waves or energy bearing particles called photons
- In wave model, EM energy propagates through space in form of sinusoidal waves
- Waves are characterised by electric field (E) and magnetic field (M), both are perpendicular to each other.

Electromagnetic Energy Radiation Waves

Electric Field

Magnetic field



Electromagnetic Spectrum – Spectral Bands

- The entire range of EMR comprises the electromagnetic spectrum subdivided in divisions called spectral bands, that share common characteristics
- The boundaries of the visible band are defined by the wavelength of human vision, while boundaries for other bands may be arbitrarily defined.
- Wavelength (frequency) is normally defined in either Angstroms (10^{-10}m), nanometers (10^{-9}m), or micrometers (10^{-6}m)
- The visible portion of the EM Spectrum ranges from 0.4mm to 0.7mm
- For remote sensing applications in the ultraviolet, visible, and infrared spectral regions, *micrometers* is the preferred unit of measurement.

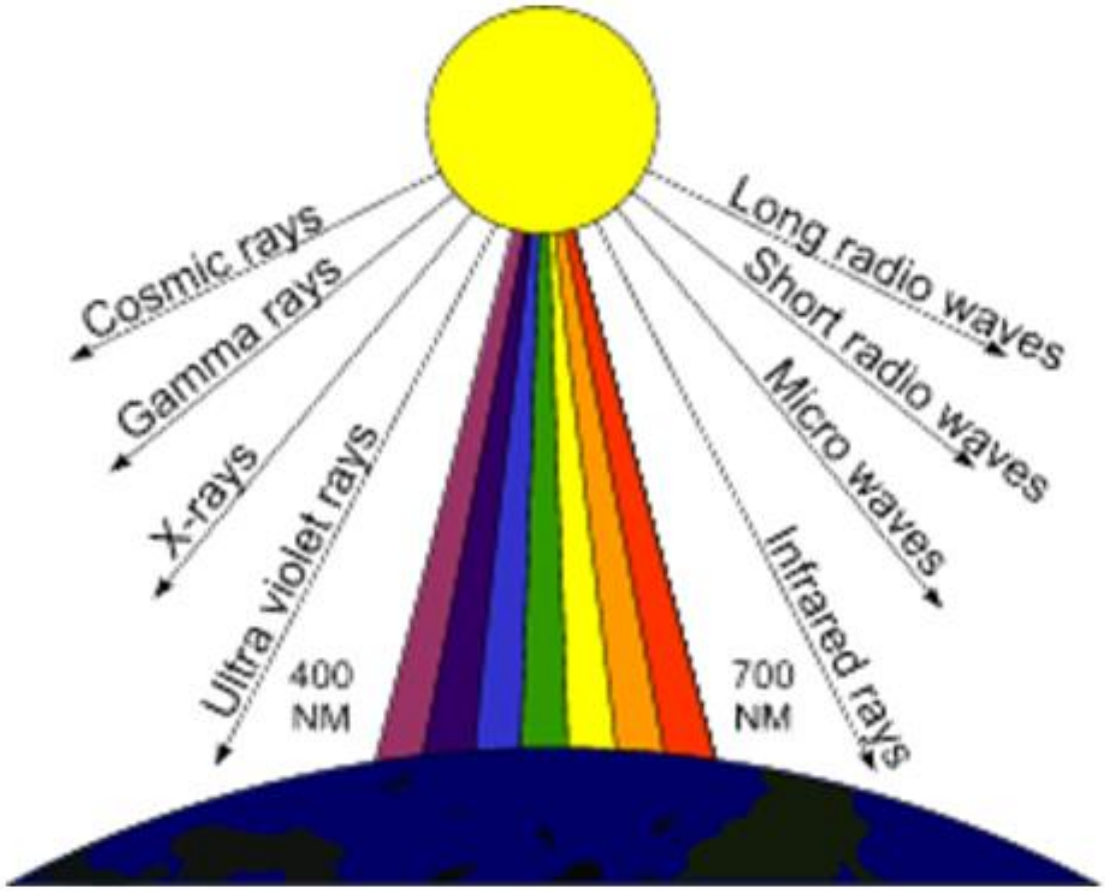
Remote Sensing Spectral Regions

- The most common bands of the EM spectrum used for remote sensing are ultraviolet (UV), visible, infrared (IR) and microwave.
- The visible spectrum is composed of three equal-wavelength segments that represent the additive primary colors (a color that cannot be made from any other).

Blue – 0.4 – 0.5 mm

Green – 0.5 - 0.6 mm

Red – 0.6 – 0.7 mm


Cosmic rays
Gamma rays
X-rays
Ultra violet rays
400
NM
700
NM
Infrared rays
Micro waves
Short radio waves
Long radio waves

Spectral Bands – Infrared and Microwave

- The Infrared (IR) band has wavelengths between the red light of the visible band at 0.7mm and microwaves at 1,000 mm (1 cm).
- The Infrared band is divided into the

Near IR – 0.7 mm – 1.5 mm

Middle IR – 1.5 mm –5.6 mm

Far IR – 5.6 mm – 1,000 mm

- The microwave band falls between the infrared and radio bands and has a wavelength range extending from approximately 0.1 cm to 1.0 m (meters)
- Microwave radiation can pass through clouds, precipitation, tree canopies and dry superficial deposits, such as sand.

Radiation – Matter Interactions

- When EMR strikes matter – it can be transmitted, reflected, scattered, or absorbed

Interaction depends on

(1) composition and physical properties of matter
(2) wavelength or frequency of radiation
(3) angle at which radiation strikes surface

- Transmission – radiation passes through matter without measurable attenuation – it's as if the matter were 'transparent' to the radiation.
- Refraction or diffraction occurs when EMR passes through matter of different densities creating a change in velocity or wavelength

Radiation – Matter Interactions

- **Reflection** – the process of radiation 'bouncing off' a smooth surface (a spectral reflector) with no change to velocity or wavelength.
- **Scattering** – radiation is dispersed or spread out unpredictably in all directions, including back in the direction of origination. Scattering more common than reflection and occurs with surfaces that are rough relative to the wavelengths of the radiation (surfaces are called diffuse reflectors). Velocity and wavelength are not affected.
- **Absorption** – Radiation taken in by matter that is opaque to radiation. Some of radiation converted to heat energy, which is subsequently emitted at thermal infrared wavelengths.

EMR – Atmosphere Interactions

- EMR travels through empty space without modification, however, at certain wavelengths, travel may be restricted.

- **Transmission bands**, or "**atmospheric windows**" are areas of the spectrum that pass unimpeded through the atmosphere.
- **Absorption bands** of the EMR represent wavelengths that are totally or partially blocked by the atmosphere
- EMR interactions with the atmosphere include

  - Absorption or re-radiation at longer wavelengths (heat energy)
  - Reflection or Scattering
  - Direct transmission in a straight-line path

Atmospheric Absorption and Scattering

- Absorption – Most significant absorbers of EMR include Oxygen, Nitrogen, Ozone, Carbon Dioxide and water vapor absorbing up to 16% of short-wave solar radiation
- Scattering – EMR within certain sections of UV, Visible and Reflected IR bands in impeded by scattering.
- Three main types of scattering important to remote sensing:
- Rayleigh scattering – blue wavelengths scattered 5 times as often as red. Creates blue sky
- Mia scattering –smoke, dust, volcanic material and salt crystals scatter longer radiation wavelengths
- Nonselective scattering – suspended aerosols (with diameters at least 10x larger than wavelengths) including all Mia particles and water droplets and ice crystals, scatter longer radiation wavelengths

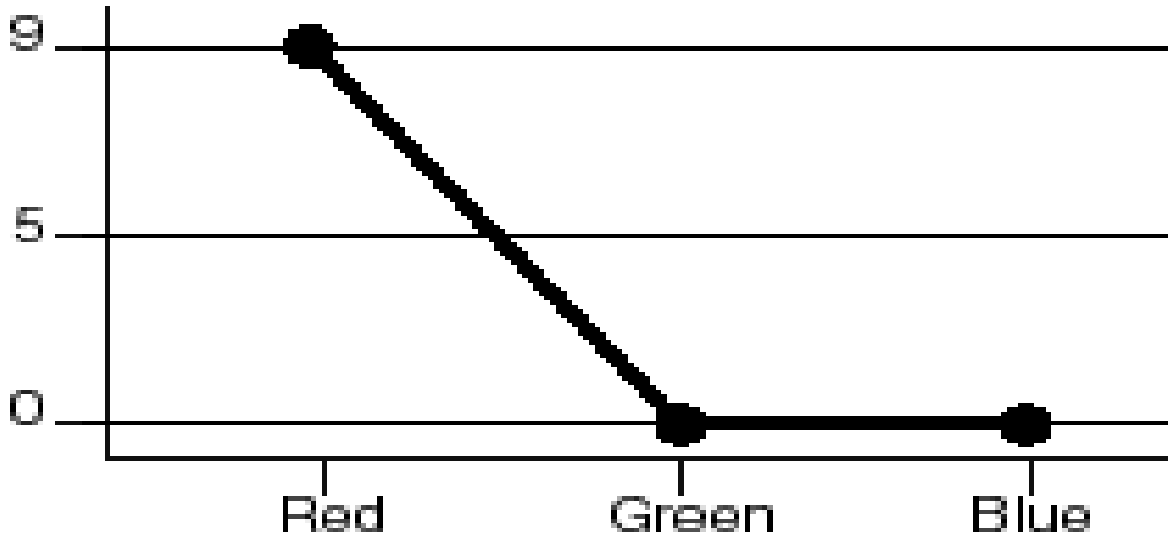
Spectral Signatures

- All objects (natural or synthetic) reflect and emit electromagnetic radiation over a range of wavelengths characteristic of the object:distinctive reflectance and emittance properties is spectral signature of object

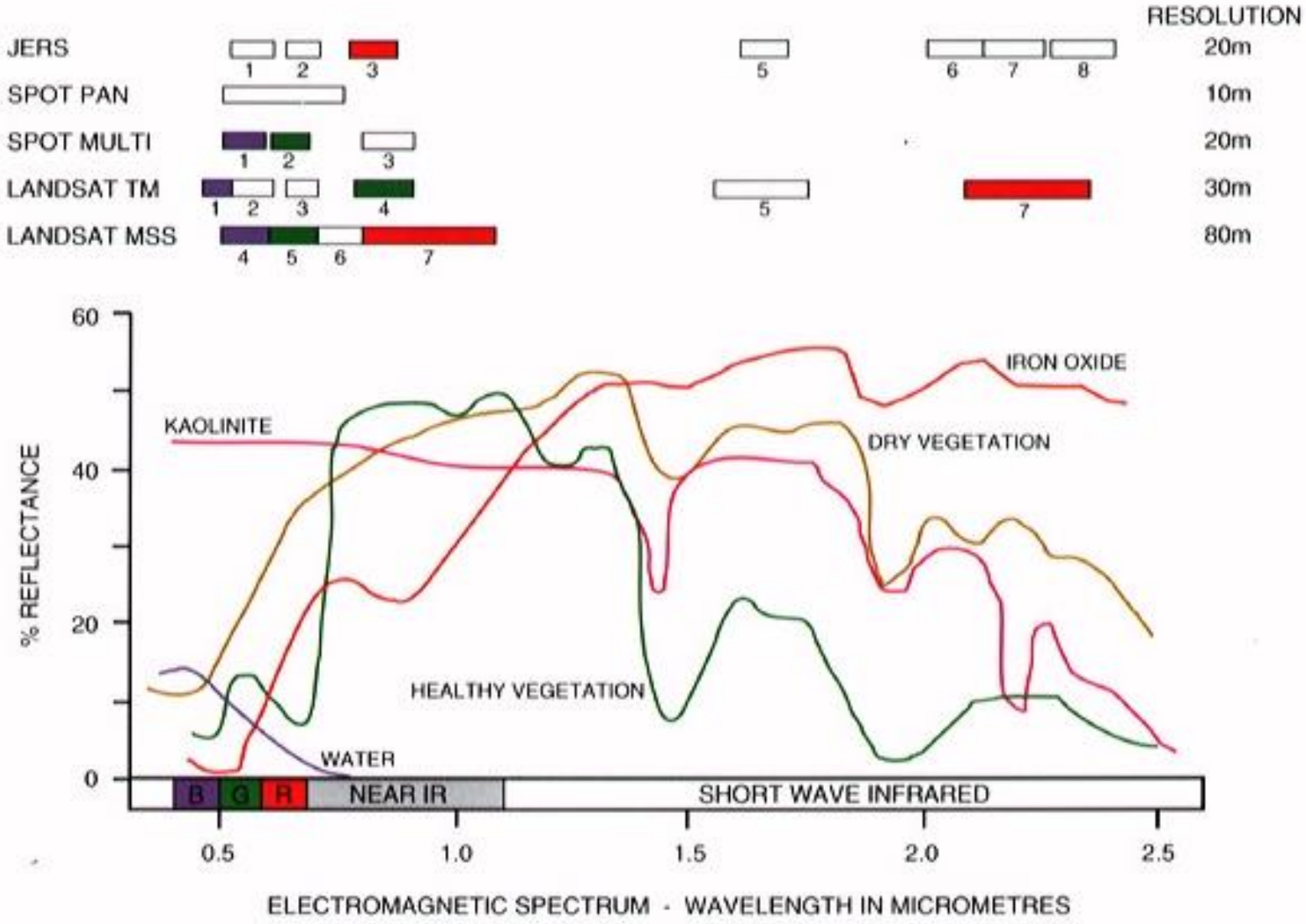
- Remote sensing depends upon operation in wavelength regions of spectrum where these spectral signatures occur for identification purposes.

Object: Apple

Color of object: Red



SPECTRAL REFLECTANCE CURVES FOR COMMON COVER TYPES WITH WAVELENGTH BANDS OF THE MAIN REMOTE SENSING SYSTEMS



Spectral Signatures

- The characteristic reflectance properties of surface features (for example soil, vegetation) are measured by the sensor and stored as digital numbers.

THE END!