**Electromagnetic Radiation (EMR)**

**Principles**

**Remote Sensing and Electromagnetic Radiation “EMR”**

• The first requirement for remote sensing is to have an **energy source** to illuminate the target. This energy is in the form of **EMR**.

• Remote sensing is concerned with the measurement of EMR returned by the Earth's natural and man-made features that first receive energy from the sun or an artificial source such as a radar transmitter.

• Different objects return different types and amounts of EMR.

• Differences in reflected EMR make it possible to identify and assess a broad range of surface features and their conditions

**ElectroMagnetic Energy**

• ***Electromagnetic energy (radiation)*** is one of many forms of energy.

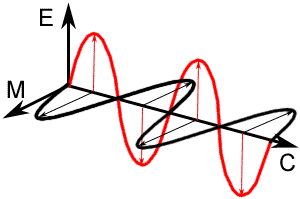
• All natural and synthetic substances above absolute zero (0 Kelvin, -273°C) emit a range of electromagnetic energy.

**ElectroMagnetic Radiation EMR**

• In the absence of matter (vacuum condition), EMR moves at the speed of light (3x108m/s);

•In matter the traveling speed becomes slower. The dense matter, the slower speed.

**Electromagnetic Radiation(EMR)**

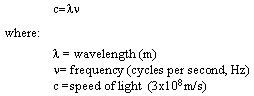
* **ElectroMagnetic Radiation *"EMR"*** consists of an ***Electrical field (E)*** and a ***Magnetic field (M)*** oriented at right angles to the electrical field. Both of them travel at the speed of light (c).
* Two characteristics of electromagnetic radiation are particularly important for understanding remote sensing. These are the:
* ***Wavelength*** and
* ***Frequency***.

**Wavelength**

1. The ***wavelength*** is the length of one wave cycle, which can be measured as the distance between successive wave crests.
2. ***Wavelength*** is usually represented by the Greek letter ***lambda*** (**λ**).
3. ***Wavelength*** is measured in meters (m) or ***nanometers*** (nm, 10-9meters), ***micrometers*** (μm, 10-6meters) or ***centimeters*** (cm, 10-2meters).

**Frequency:**

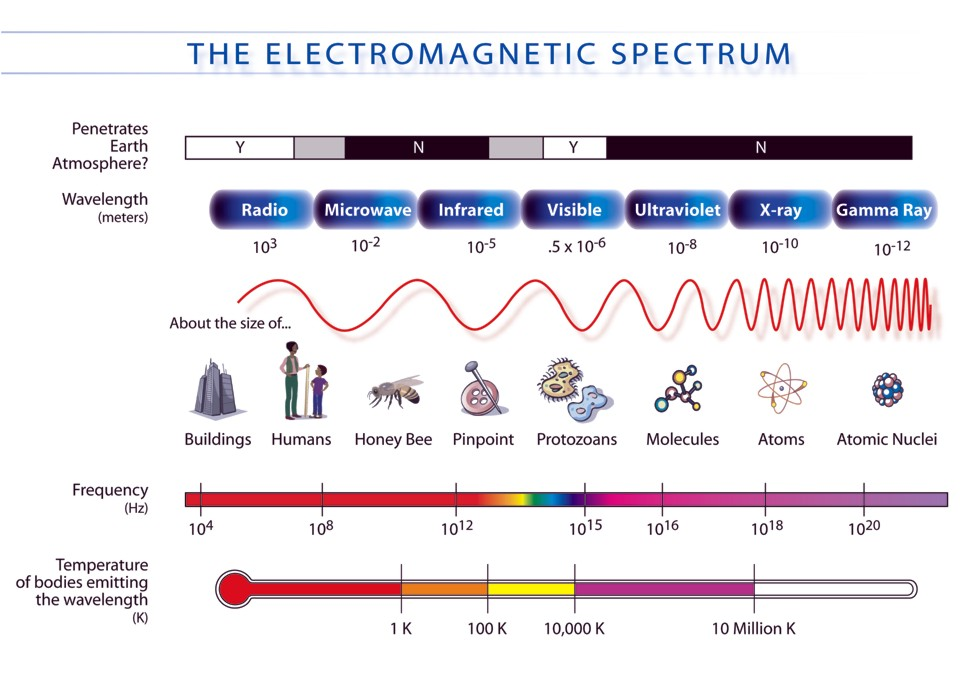
1. Refers to the number of cycles of a wave passing a fixed point per unit of time.
2. ***Frequency*** is measured in **hertz** (Hz), equivalent to one cycle per second.
3. ***Wavelength*** and ***frequency*** are related by the following formula:



1. ***Wavelength*** and ***frequency*** are inversely related to each other.
2. The shorter the wavelength, the higher the frequency.

**The Electromagnetic Spectrum (EMS)**

1. ***EMS*** ranges from the shorter wavelengths (including gamma and x-rays) to the longer wavelengths (including microwaves and broadcast radio waves).



1. The light which our eyes can ***detect*** is part of the ***visible spectrum***.
2. ***The invisible spectrum*** can not see it by our eyes, but can be detected by other remote sensing instruments and used to our advantage.

**Visible wavelengths**: cover a range from 0.4 to 0.7 μm. The longest visible wavelength is ***red*** and the shortest is ***violet***.

**Primary Colors: *Blue***, ***Green***, and R***ed*** are the primary colors or wavelengths of the visible spectrum.

**Visible**

• Small portion of the EMS that humans are sensitive to, includes: 1) **Blue** (0.4-0.5 µm), 2) **Green** (0.5-0.6 µm), and 3) **Red** (0.6-0.73 µm)

**Infrared (IR) wavelength:**

1. It covers the wavelength range from 0.7 µm to 1 mm.
2. The infrared region can be divided into two categories based on their radiation properties; the ***reflected IR***, and the ***emitted*** or ***thermal*** IR.

**Microwave region**: The portion of the spectrum of more recent interest to remote sensing is the ***microwave region*** from about 1 mm to 1 m.

**Polarized EMR**

1. The ***electric*** and ***magnetic*** vibrations associated with a quantum can be in any orientation at ***right angles*** to the direction of propagation.
2. If the fields for all quanta are lined up in *one direction* by some means, the radiation becomes ***polarized*** plane, ***horizontal*** or ***vertical polarization***.

**Blackbody Model**

• ***Blackbody*** is a hypothetical, ideal radiator that totally absorbs and re-emits all energy incident upon it, namely, perfect absorber and emitter of radiation.

• Emittance is a function only of temperature.

**Sources of EMR**

* All matter in the universe that is warmer than 0K (-273C) emit continuously electromagnetic radiation.
* All objects in every day life emit ***EMR***.
* The amount and type of the emitted energy depends on the temperature of object.
* The ***hotter*** objects emit more energy with ***shorter*** wavelengths.