University of Anbar
College of Science – Applied Geology Department
Dr. Omar AL-Jarrah
Assis. Professor

2nd Stage

Remote Sensing

Lecture 2 : Electromagnetic waves

Electromagnetic Energy

The way that the information transfer from the target to the sensor , this can be in frequency or intensity or polarization for electromagnetic waves . This information diffuse direct as electromagnetic energy with light speed thru the outer space or in internal media .

Or it can transfer as in not direct way such as reflect or diffuse or emitted .

The type of energy is beam of tow perpendicular fields one of them electric and other magnetic , moving by light speed (300 000 km / sec) with harmonic motion .

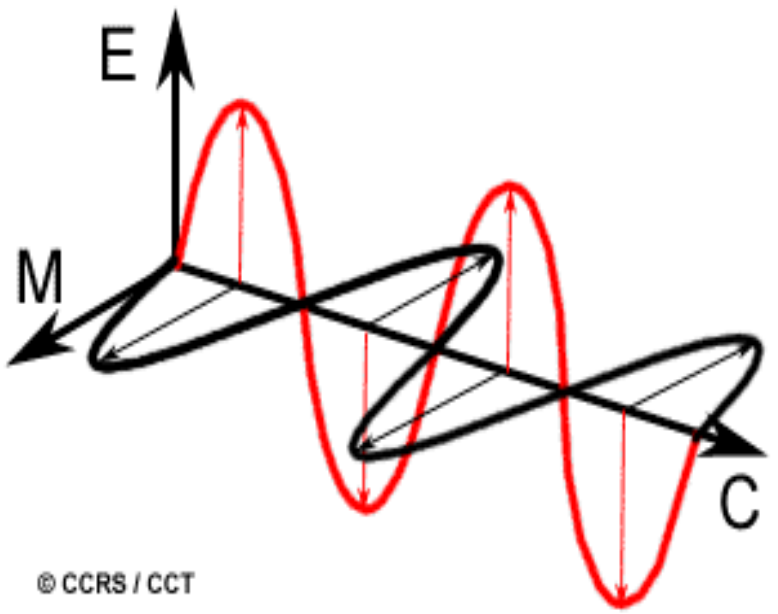
EM wave is

Electric field (E) perpendicular to

magnetic field (M)

Travels at velocity, c ($3x10^8$ ms^{-1}, in a

vacuum)

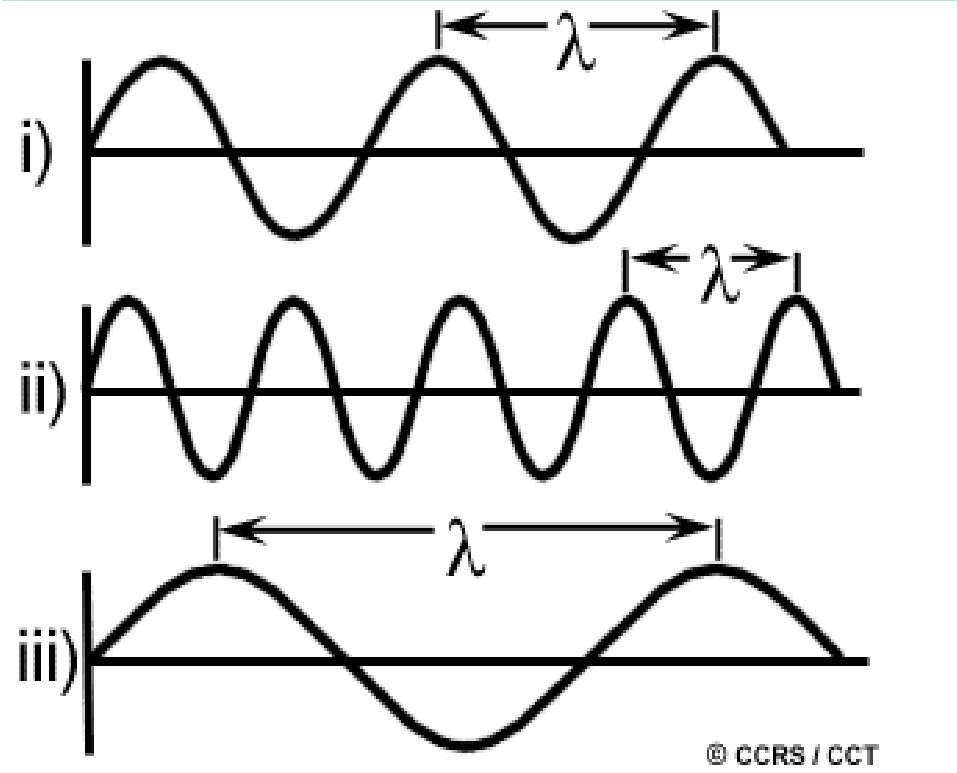


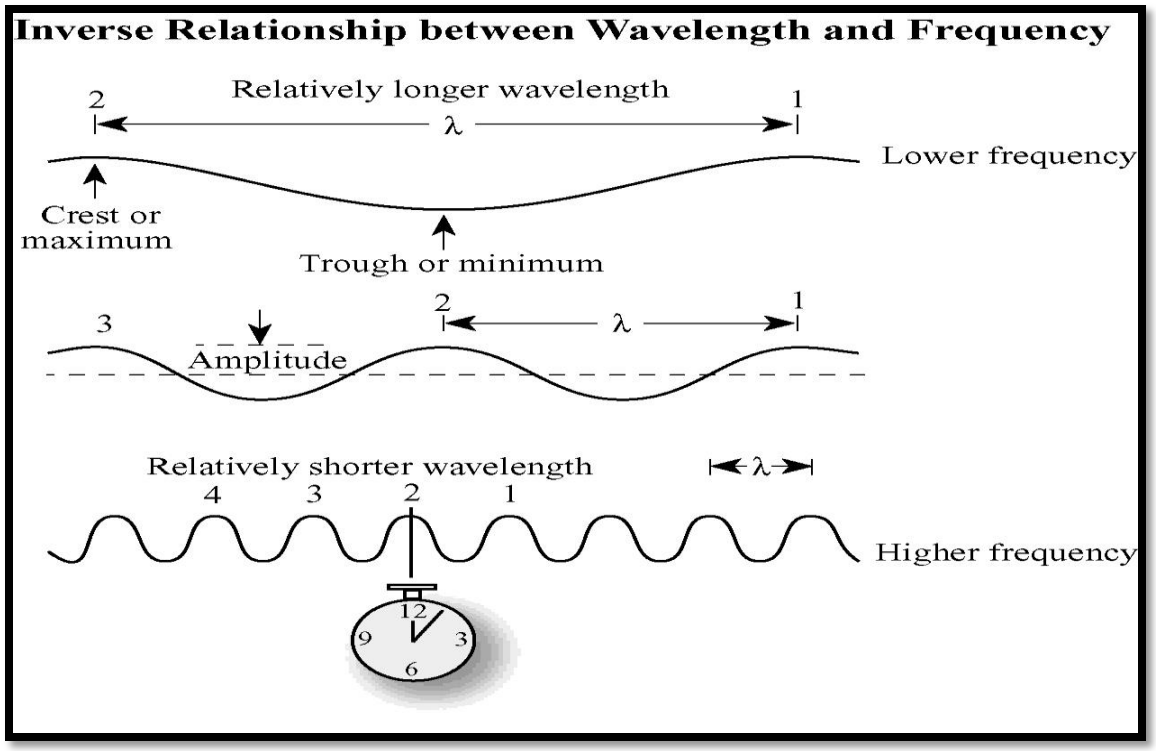
The Electromagnetic waves when transfer for long distance it become weak and may be disappear .

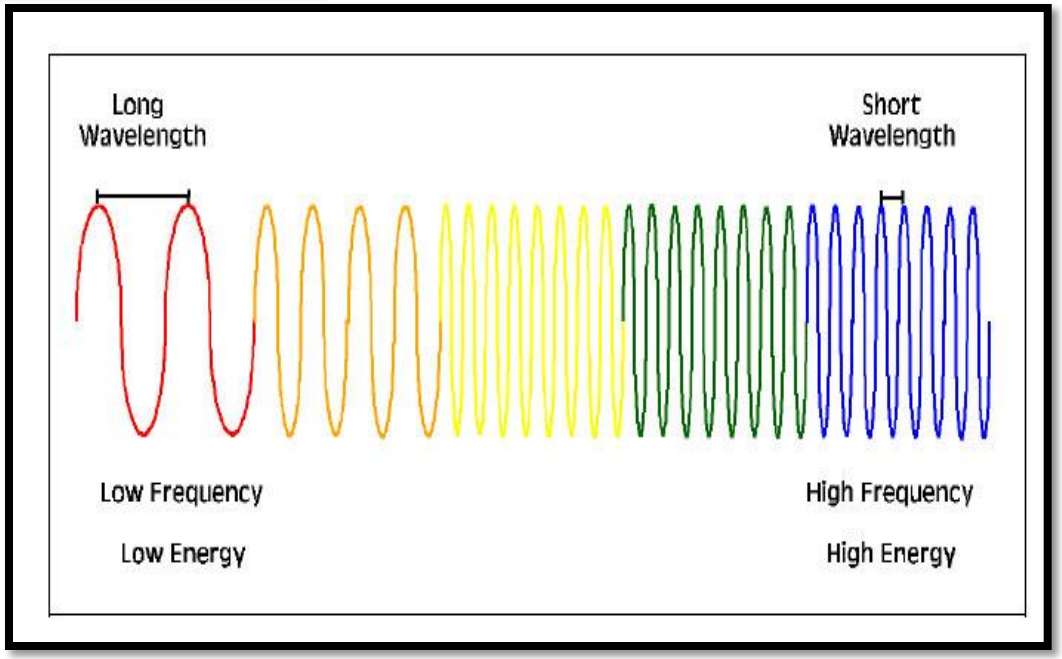
Distance between tow peak of wave called (λ Wave length)

Number of peaks pass thru fix point in time unit called (Frequency F)

The distance between the peak an bottom of wave called (Amplitude A)



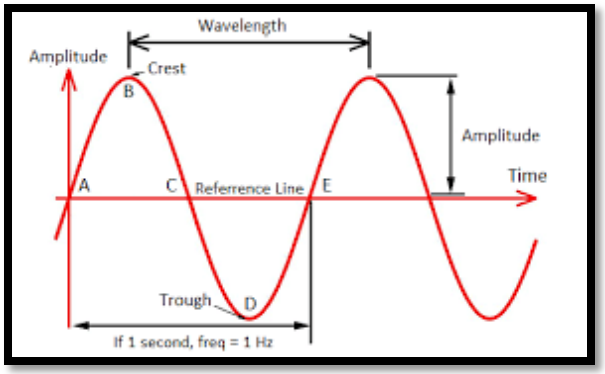

Inverse Relationship between Wavelength and Frequency
Relatively longer wavelength
2
1
λ
Lower frequency
Crest or maximum
Trough or minimum
3
Amplitude
2
1
λ
Relatively shorter wavelength
λ
4
3
2
1
Higher frequency
12
9
3
6


Long Wavelength
Short Wavelength
Low Frequency
Low Energy
High Frequency
High Energy

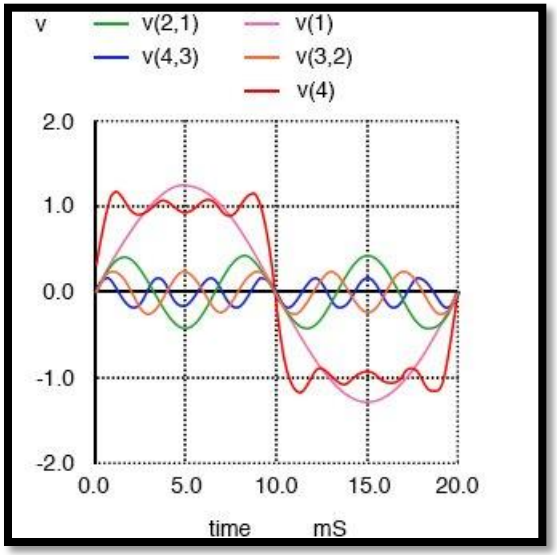
VELOSITY OF WAVES (simple & combined)

The Electromagnetic waves transfer by its special phase with time unit

1 – Simple wave : when t = 0 , the wave at right place but after Δt of time , the wave move to another place with same phase and by displacement = UP Δt



2 – Combined wave (multi phases) : the general wave at t = 0 has one phase or more with different distances but after Δt the waves move with each phase to different distances , and the total distance = addition of these waves .



Doppler effect

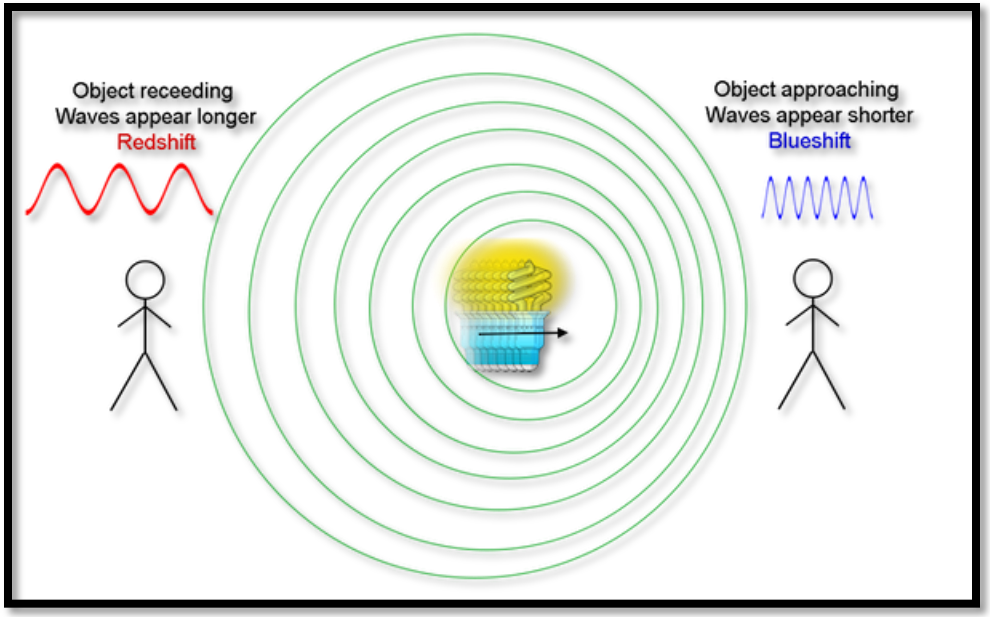
The physical principles of that ((constant frequency ν for electromagnetic waves between the body give the energy and the observer within defined distance)) , this relation may change if any move happened between these two sources then the frequency also changes and called $\bar{\nu}$. And the general Law be

$\nu d = \bar{\nu} - \nu$

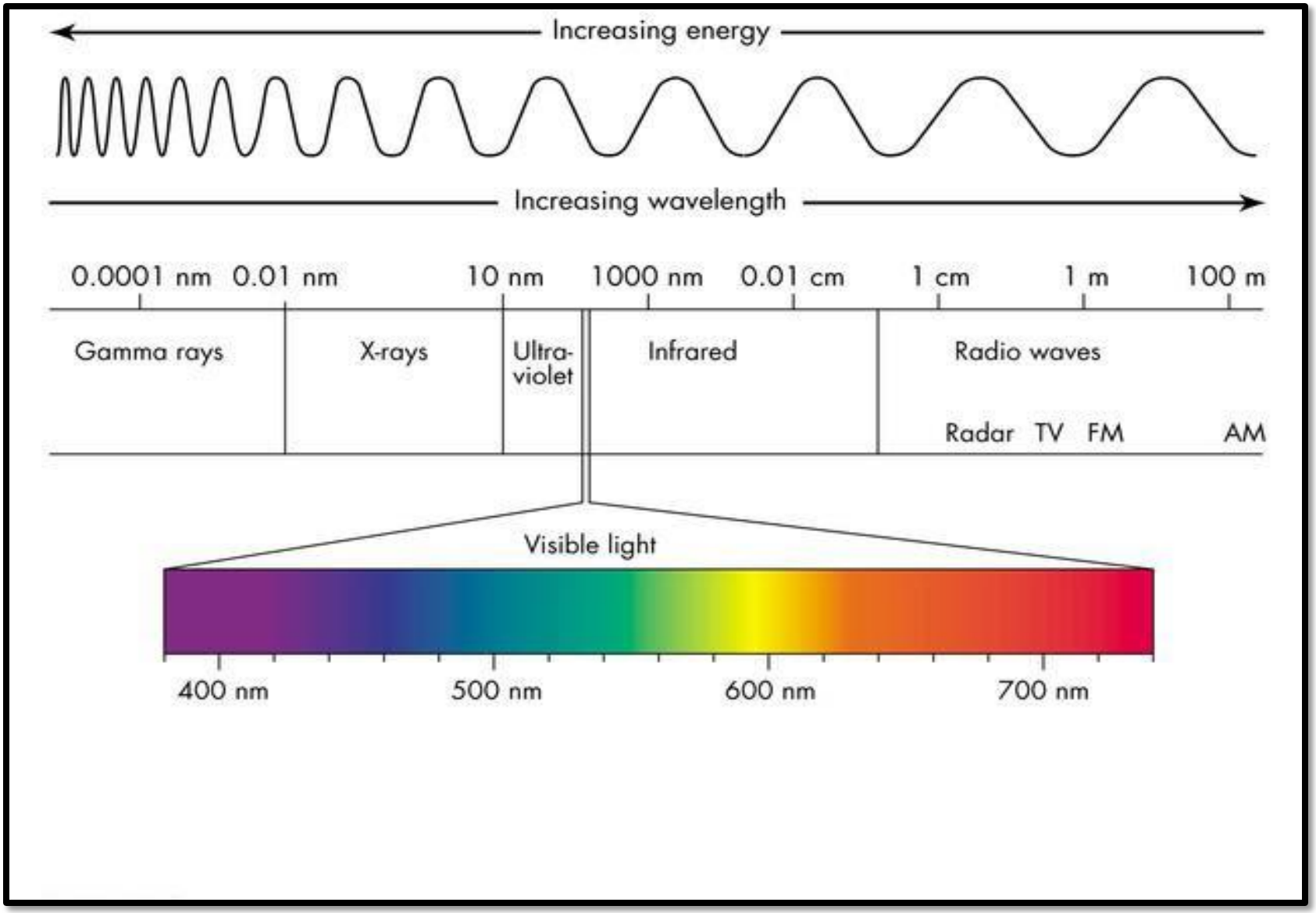
so if the distance reduce the frequency will increase and v d be (+ ve)

And if it increase the frequency will decrease and v d be (– ve)

- Ve



+ Ve


Increasing energy
Increasing wavelength
0.0001 nm
0.01 nm
10 nm
1000 nm
0.01 cm
1 cm
1 m
100 m
Gamma rays
X-rays
Ultra-violet
Infrared
Radio waves
Radar
TV
FM
AM
Visible light
400 nm
500 nm
600 nm
700 nm

Region Name	Wavelength	Comments
Gamma Ray	< 0.03 nanometers	Entirely absorbed by the Earth's atmosphere and not available for remote sensing.
X-ray	0.03 to 30 nanometers	Entirely absorbed by the Earth's atmosphere and not available for remote sensing.
Ultraviolet	0.03 to 0.4 micrometers	Wavelengths from 0.03 to 0.3 micrometers absorbed by **ozone** in the Earth's atmosphere.
Visible	0.4 to 0.7 micrometers	Available for remote sensing the Earth. Can be imaged with photographic film.
Infrared	0.7 to 100 micrometers	Available for remote sensing the Earth. Can be imaged with photographic film.

Thermal	3.0 to 14 micrometers	Available for remote sensing the Earth. This wavelength cannot be captured with photographic film. so mechanical sensors are used to image this wavelength band.
Microwave or Radar	0.1 to 100 centimeters	Longer wavelengths of this band can pass through clouds, fog, and rain. Images using this band can be made with sensors.
Radio	> 100 centimeters	Not normally used for remote sensing the Earth.

References

IMAGE INTERPRETATION IMAGE INTERPRETATION , Seventh Edition, Lillesand T. M., Kiefer R. W., Chipman J. W., WILEY press , USA , 2015

Earth Science Satellite Remote Sensing Vol. 1: Science and Instruments , Qu J. J., Gao W. , Kafatos M. , Murphy R. E, Salomonson V. V., Tsinghua University Press, Beijing and Springer-Verlag GmbH Berlin Heidelberg . 2006

Internet Remote Sensing Lectures sites