LESSON 2
Basics of Remote Sensing
(contd)

SUMMARY OF LECTURE 1

Remote Sensing Definition

Component of Remote sensing

Planck's Law

Peak wavelength from sun and earth

Available radiation for RS from sun
OR
Wavelength or EM waves absorbed by atmosphere

https://www.nrcan.gc.ca/maps-tools-publications/satellite-imagery-air-photos/tutorial-fundamentals-remote-sensing/9309

REMOTE SENING DATA COLLECTION METHODS

OPTICAL/IR REMOTE SENSING

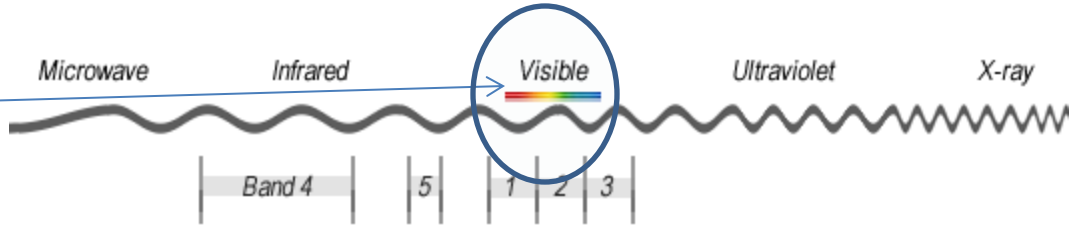
PANCHROMATIC

COLOR

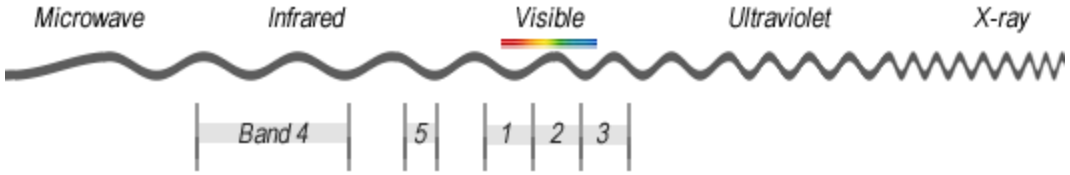
MULTISPECTRAL

HYPERSPECTRAL

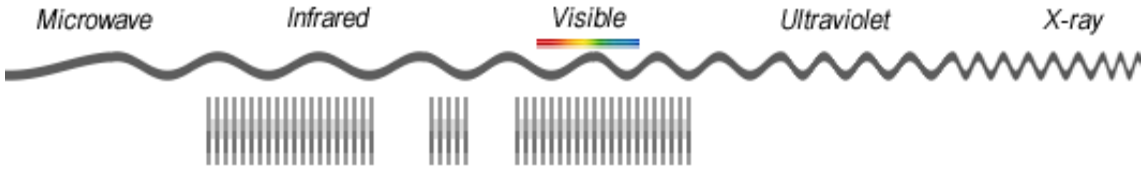
Panchromatic

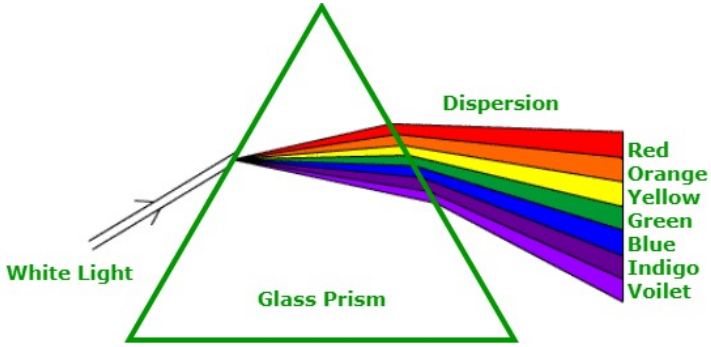


Multispectral

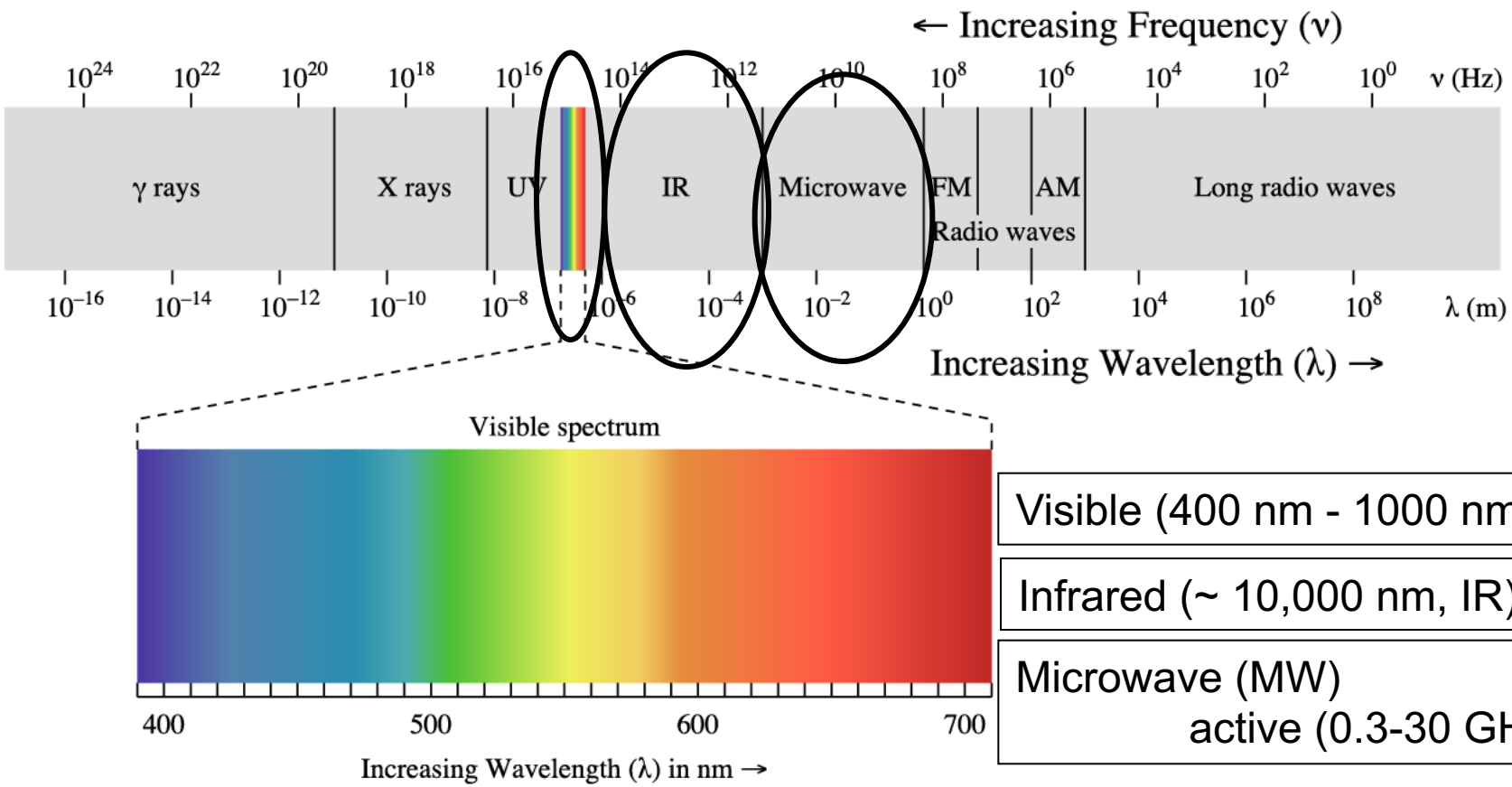


Hyperspectral





Electromagnetic spectrum



Visible (400 nm - 1000 nm, VIS)

Infrared (~ 10,000 nm, IR)

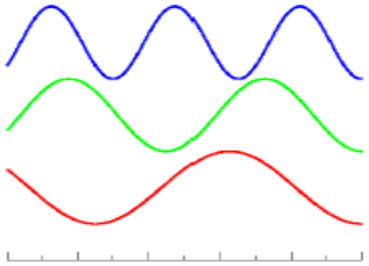
Microwave (MW)
active (0.3-30 GHz)

Links:
http://www.biogeorecon.com/remote.htm
http://www.eeb.ucla.edu/test/faculty/nezlin/SatellitesAndSensors.htm

Comparison:

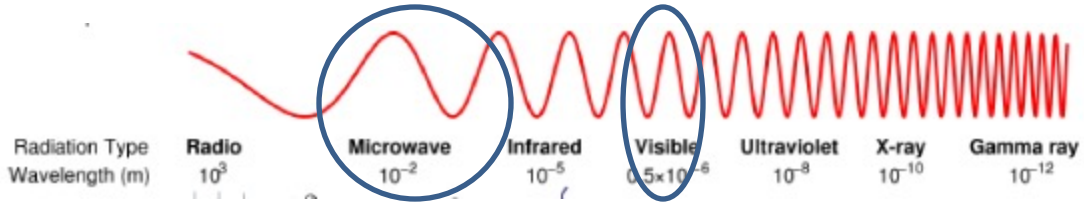
Micron= mm/1000

Violet	380-435
Blue	435-500
Cyan	500-520
Green	520-565
Yellow	565-590
Orange	590-625
Red	625-740



Radar Band	Frequency (GHz)	Wavelength (cm)
Millimeter	40 to 100	0.75 to 0.30
Ka	26.5 to 40	1.1 to 0.75
K	18 to 26.5	1.7 to 1.1
Ku	12.5 to 18	2.4 to 1.7
X	8 to 12.5	3.75 to 2.4
C	4 to 8	7.5 to 3.75
S	2 to 4	15 to 7.5
L	1 to 2	30 to 15
UHF	0.3 to 1	100 to 30

Wavelength (Microwave) >>> Wavelength (optical region)



In meters

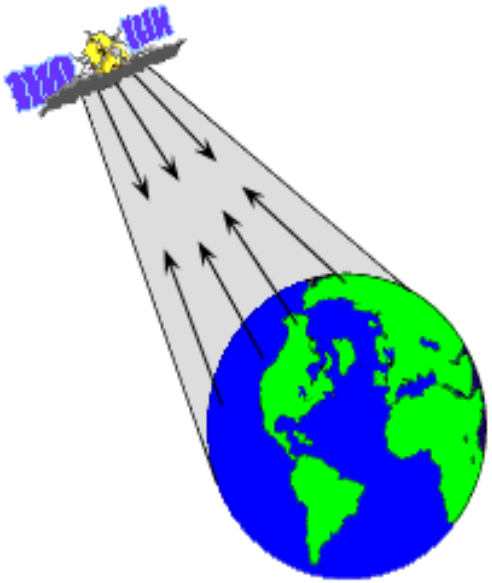
Type of Remote Sensing

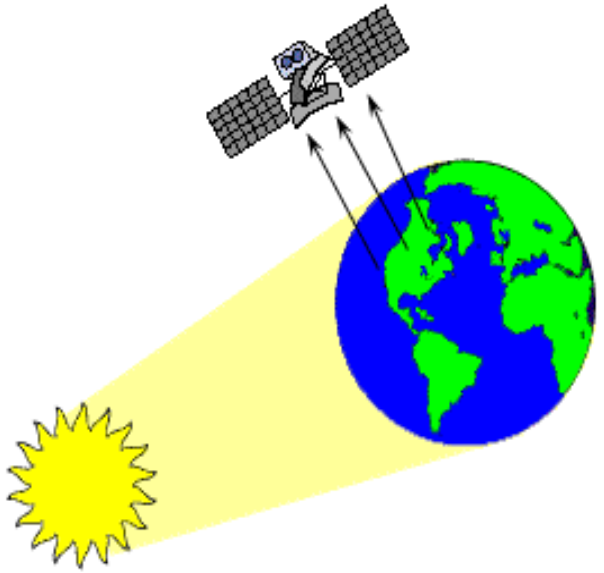
#Based on wavelength region

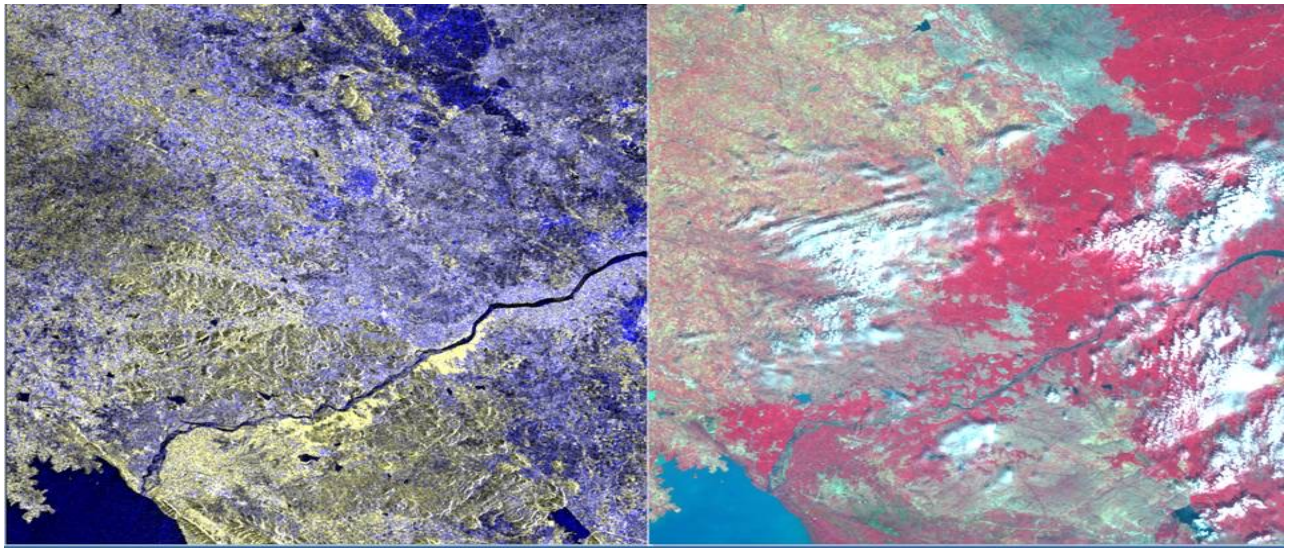
Based on radiation source

Active remote sensing

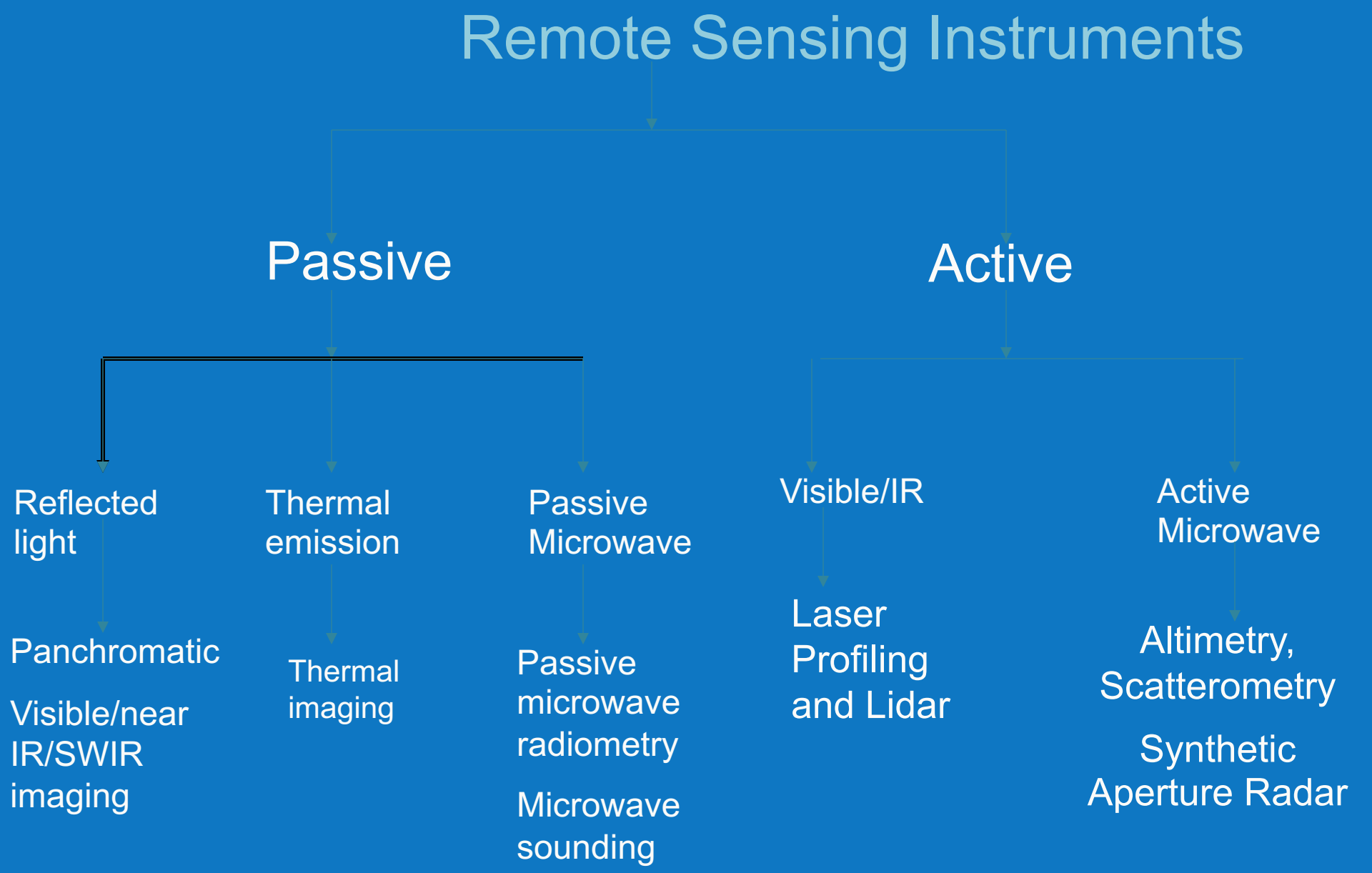
Passive remote sensing



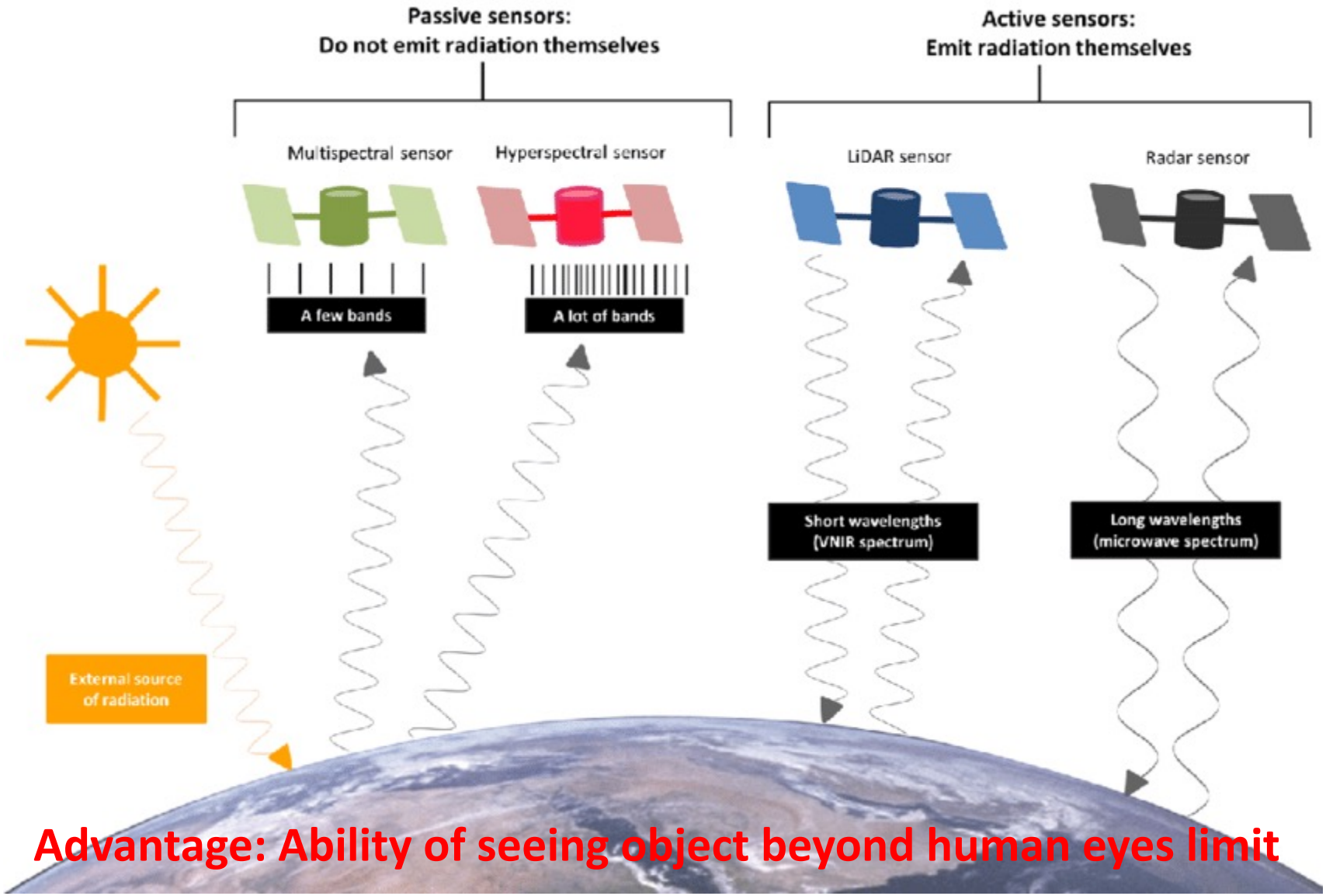




A Systems View of Remote Sensing



What are Type of Remote sensing: PASSIVE & ACTIVE



Advantage: Ability of seeing object beyond human eyes limit

Advantage of Remote Sensing

i) Provide data of large region- Synoptic view

ii) Provide data of remote and inaccessible terrain

iii) Ability to obtain data of any region for repeated period of time.

iv) Ability to acquire data at any time of day

v) Ability to acquire data in cludy condition

vi) relatively less cost as compared to human intensive mapping.

v) Easy and rapid method of mapping

vi) No human bias.

vii) Can acquire data beyond human vision.

viii) Quick information

ix) Multispectral view

INTERACTION OF LIGHT WITH SURFACE MATERIAL

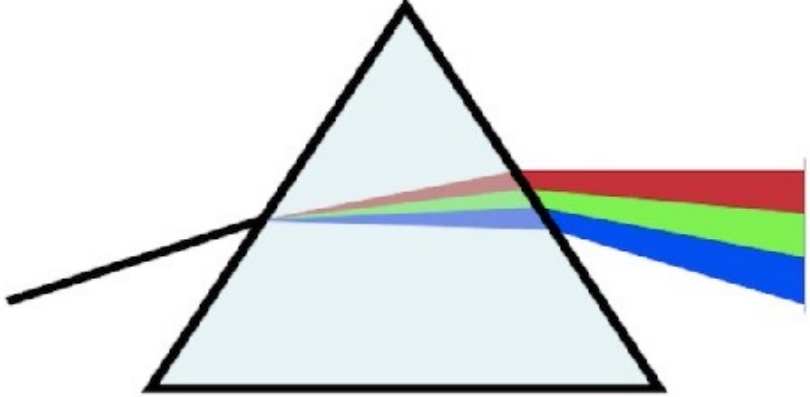
HOW WE SEE COLORS- HUMAN AND INSTRUMENT SIMILIARITY

LIGHT ABSORPTION, SCATTERING AND TRANSMISSION

HOW MUCH ADVANTAGE:SPECTRAL VIEW

SIGNATURE: A KEY OF REMOTE SENSING DATA INTERPRETATION

WHAT ARE PANCHROMATIC, MULTISPECTRAL AND HYPERSPECTRAL OBSERVATIONS



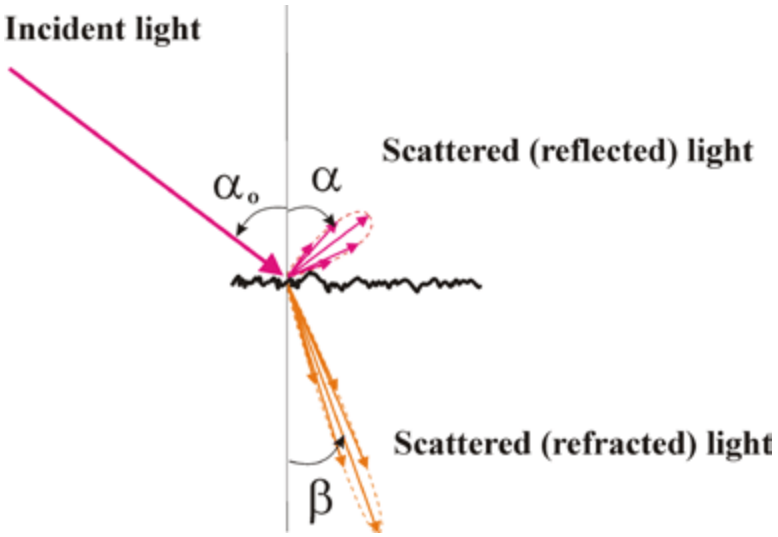
blue light, with a higher refractive index, will be bent more strongly than red light, resulting in the well-known rainbow pattern.

Color	Wavelength
Violet	4000 Å to 4240 Å
Blue	4240 Å – 4912 Å
Green	4912 Å – 5750 Å
Yellow	5750 Å – 5850 Å
Orange	5850 Å – 6470 Å
Red	6470 Å – 7000 Å

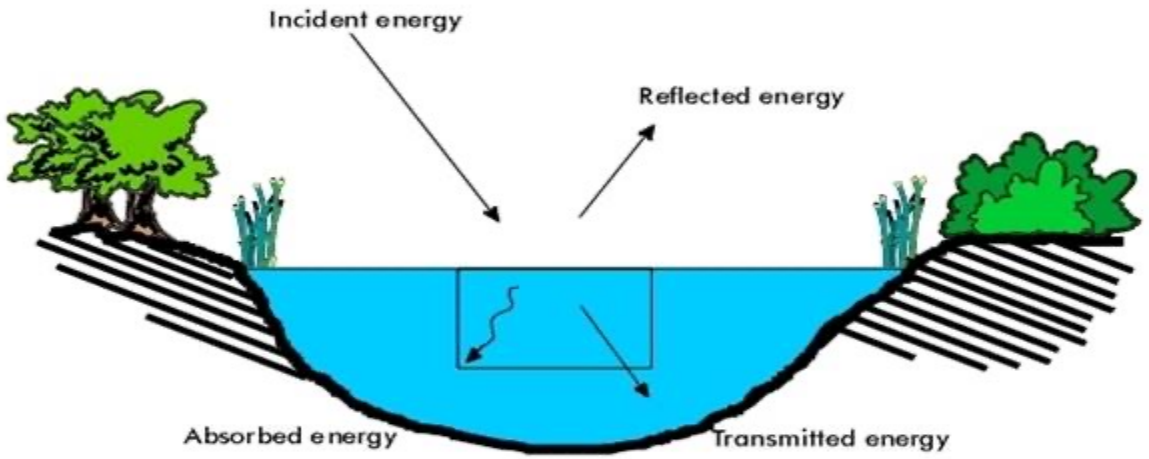
Reflection is the process by which electromagnetic radiation is returned either at the boundary between two media (surface reflection) or at the interior of a medium (volume reflection)

transmission is the passage of electromagnetic radiation through a medium.

Both processes can be accompanied by **diffusion** (also called **scattering**), which is the process of deflecting a unidirectional beam into many directions. In this case, we speak about **diffuse reflection** and **diffuse transmission**



INTERACTION OF RADIATION SURFACE MAtERIAL



There are three forms of interaction that can take place when energy strikes, or is incident (I) upon the surface. These are: **absorption (A); transmission (T); and reflection (R)**

$\Phi\lambda = \rho\lambda + \alpha\lambda + \tau\lambda$ [where $\Phi\lambda$ is radiative flux; $\rho\lambda$ is the amount of reflected energy; $\alpha\lambda$ is the amount of absorbed energy; and $\tau\lambda$ is the amount of transmitted energy]

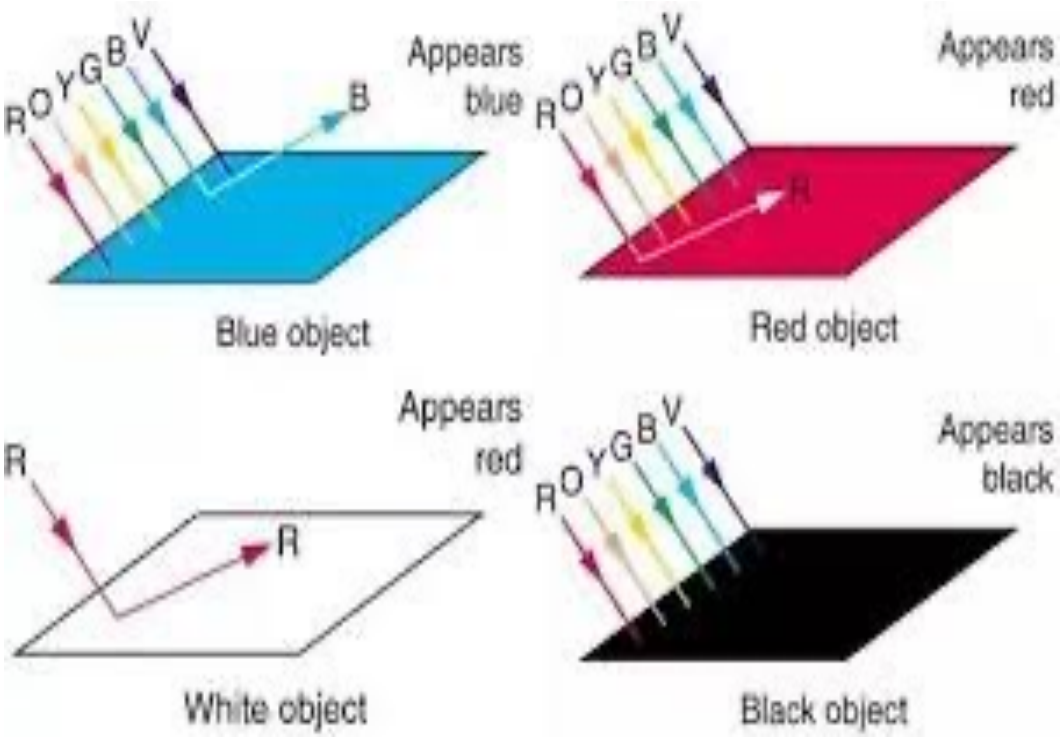
https://www2.geog.soton.ac.uk/users/trevesr/obs/rseo/energy_interactions_with_the_earths_surface.html

Where Does Color Come From?

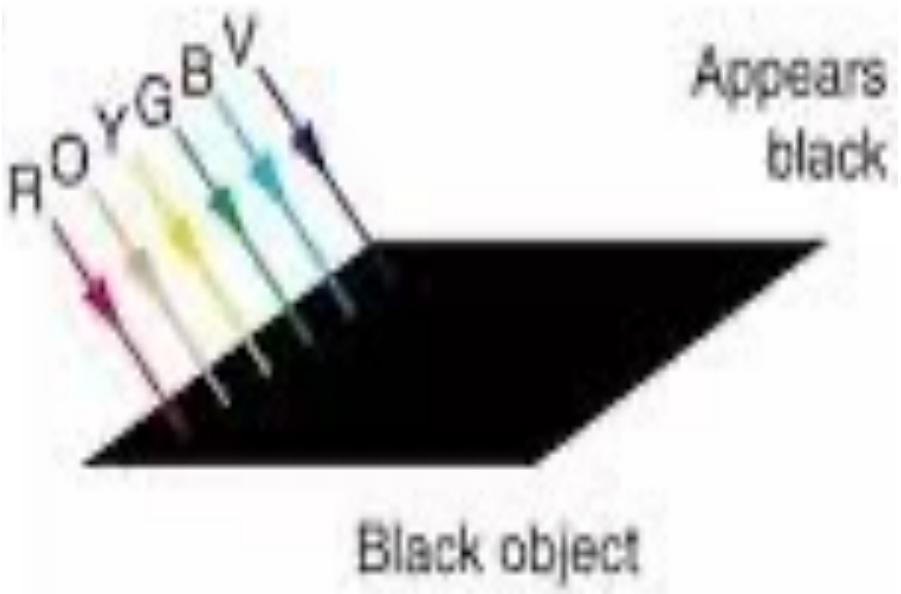
The color of an object is not actually within the object itself.

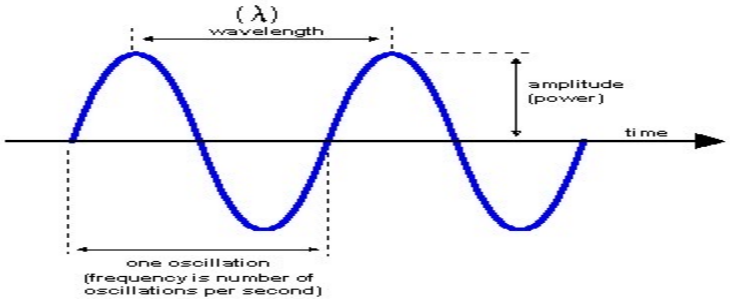
Rather, the color is in the light that shines upon it and is ultimately reflected

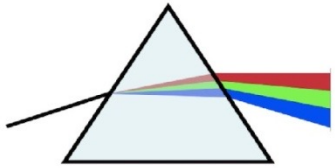
visible light spectrum consists of a range of frequencies, each of which corresponds to a specific color



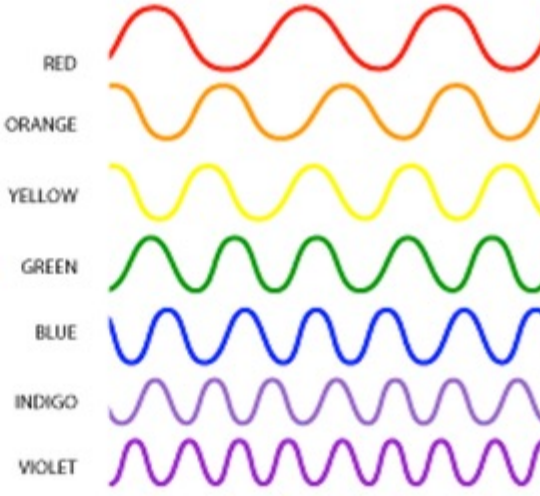
Darker colored objects heat up faster in the sun than light colored ones, which is why running across asphalt in bare feet can feel much hotter than walking across light-colored concrete

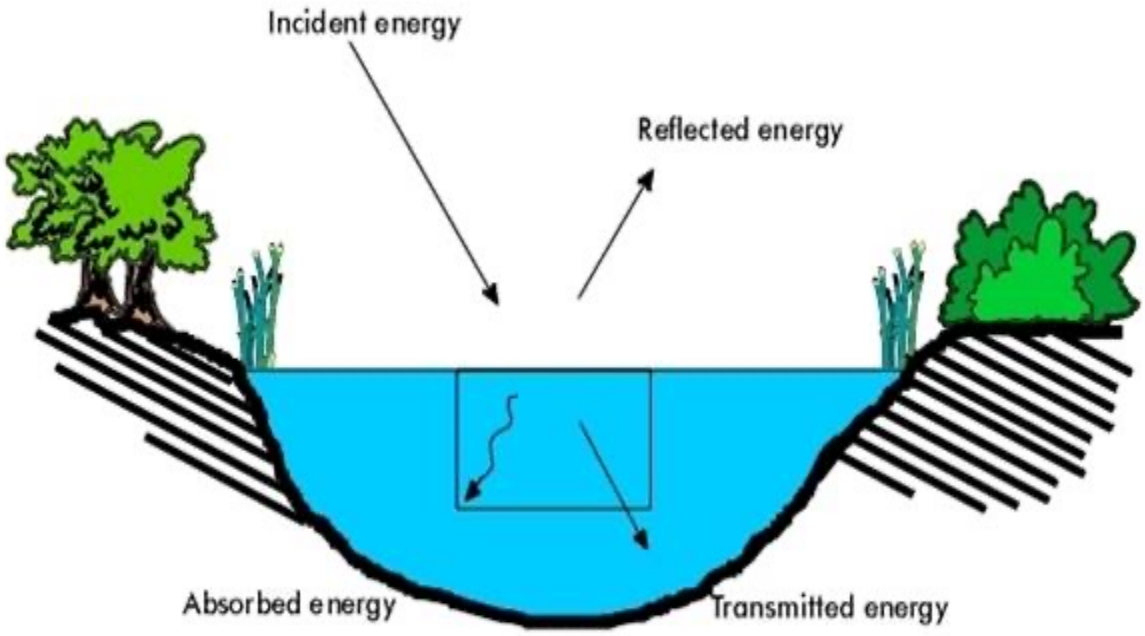






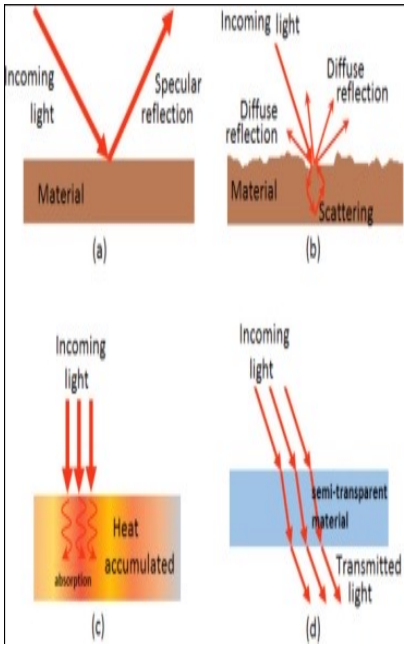
Color	Frequency	Wavelength
Violet	668 THz to 789 THz	400 to 440
Indigo	600 THz to 700 THz	440 to 460
Blue	606 THz to 668 THz	460 to 500
Green	526 THz to 606 THz	500 to 570
Yellow	508 THz to 526 THz	570 t0 590
Orange	484THz to 508 THz	590 to 620
Red	400 THz to 484 THz	620 to 720

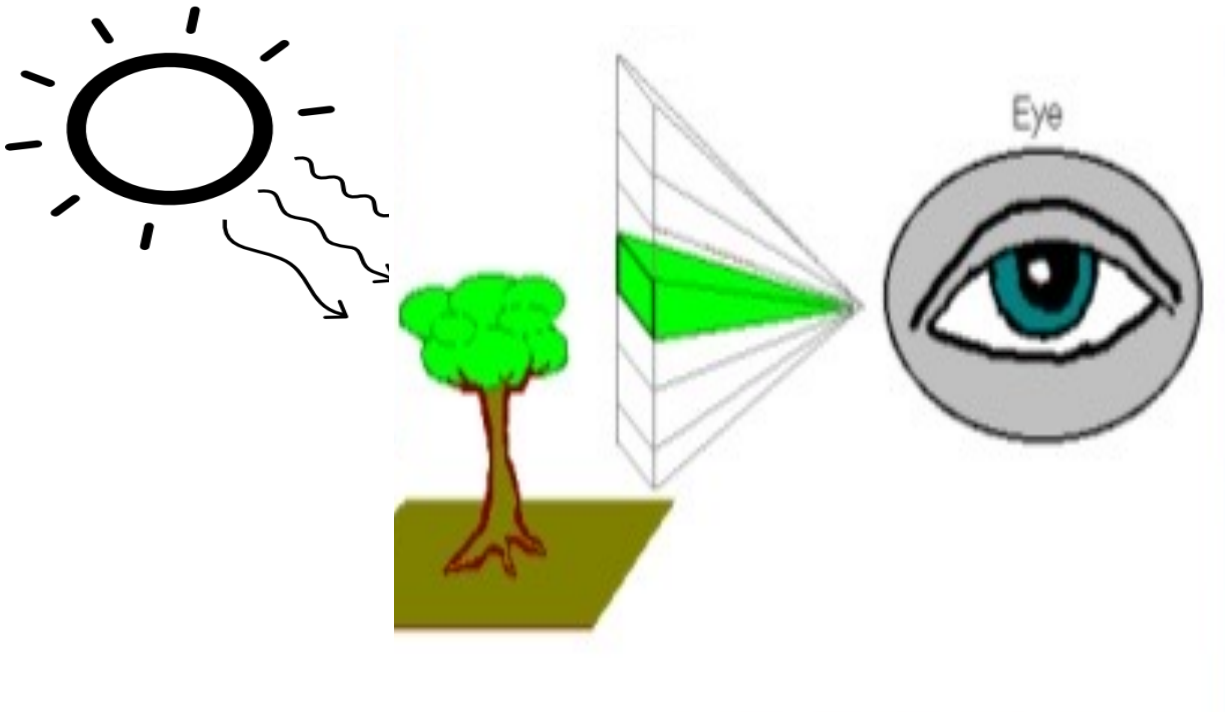


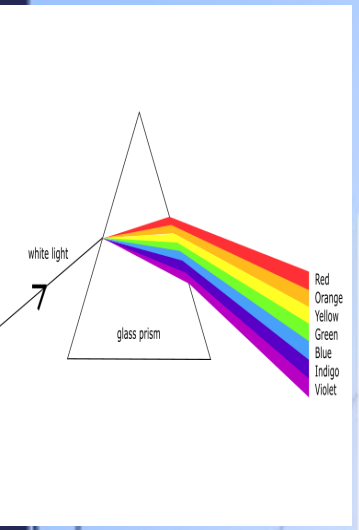

Incident energy
Reflected energy
Absorbed energy
Transmitted energy

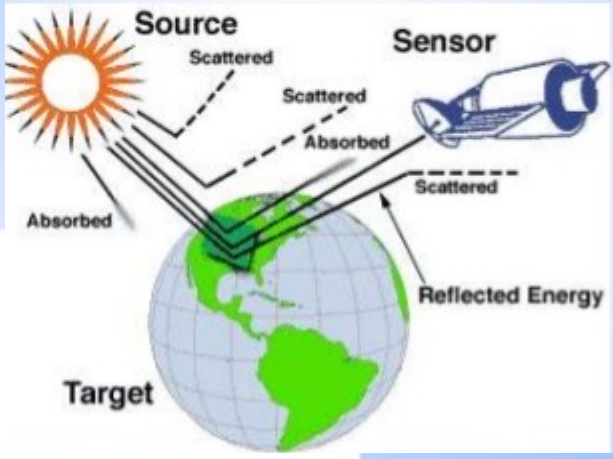
Radiation Interactions with Matter

- ***Emission** – release of electromagnetic waves (Planck's Law of radiation)*
- ***Absorption** – receiving of electromagnetic waves*
- ***Scattering** – deflection of electromagnetic waves in all directions (Surface roughness relative to wavelength)*
- ***Reflection** – deflection of electromagnetic waves into the backwards direction (Smooth surface)*

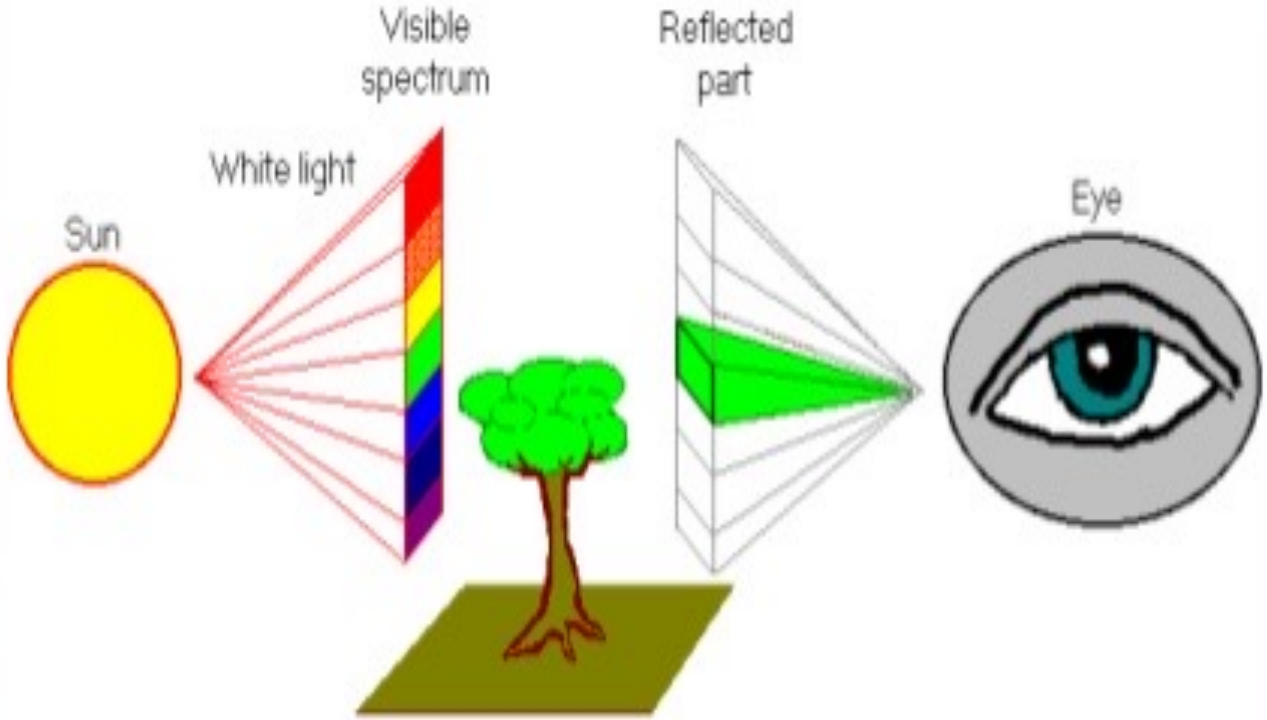


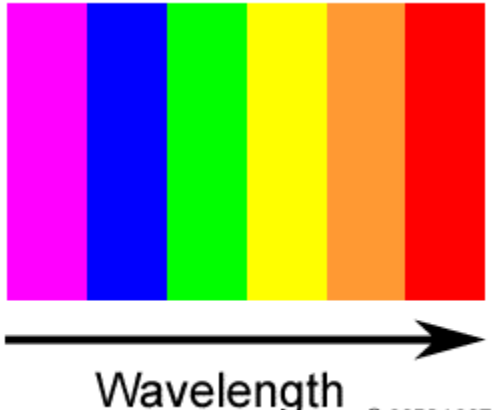

Eye

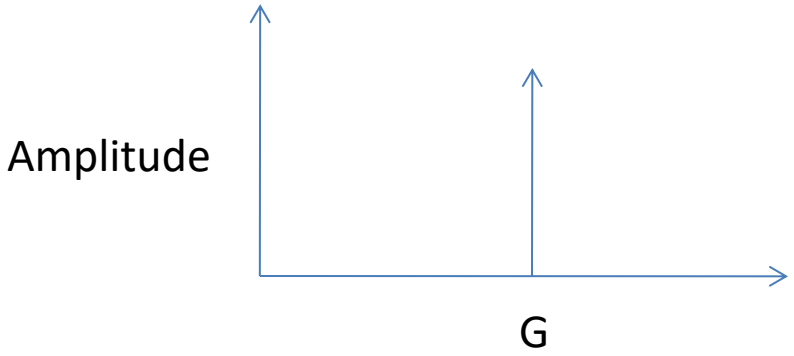




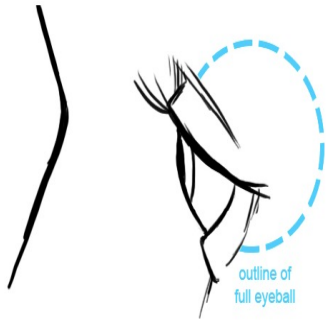
Reflection of colours

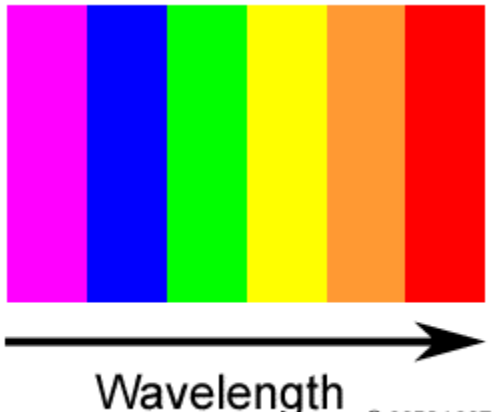


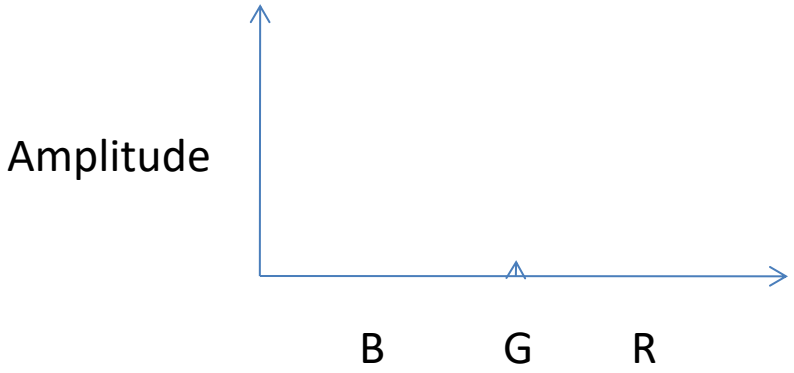

Wavelength


Amplitude
G

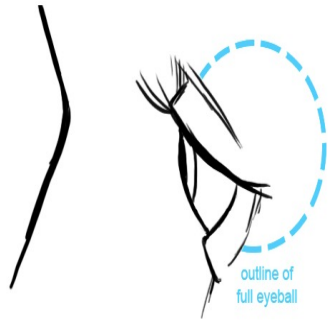

shutterstock

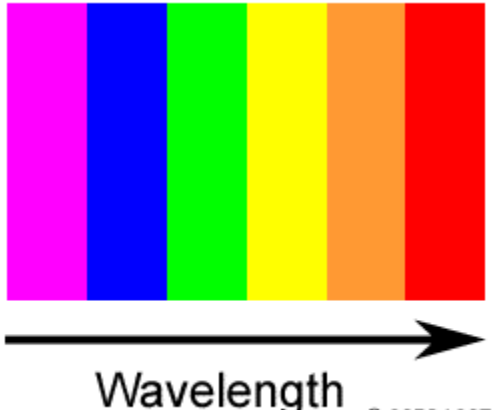

outline of
full eyeball

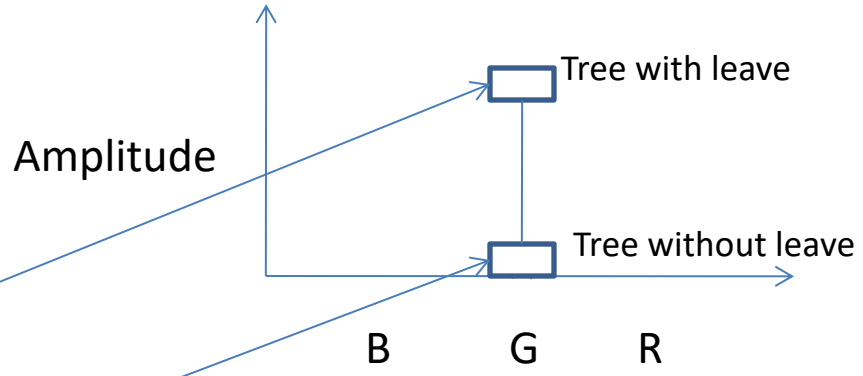




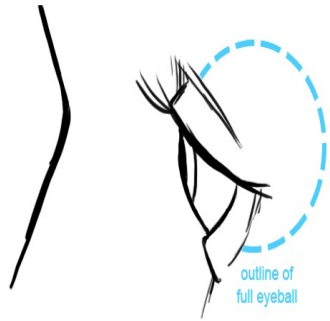
Leaf Fall



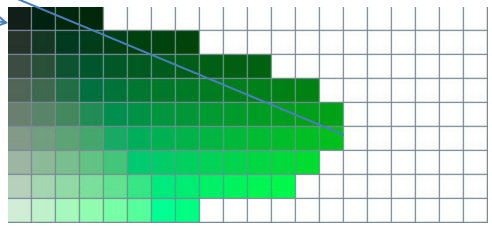

Wavelength

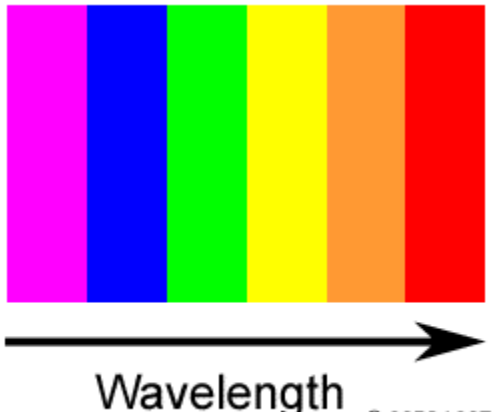

Amplitude
Tree with leave
Tree without leave
B
G
R

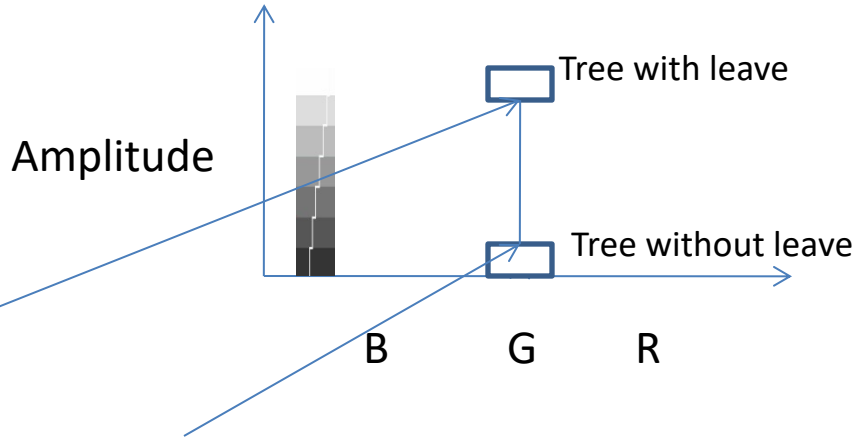

shutterstock


outline of
full eyeball

LOCATION

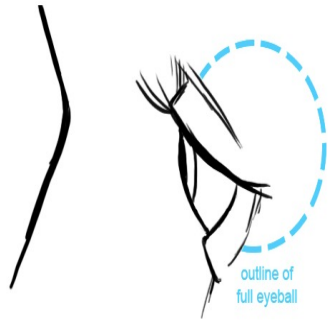


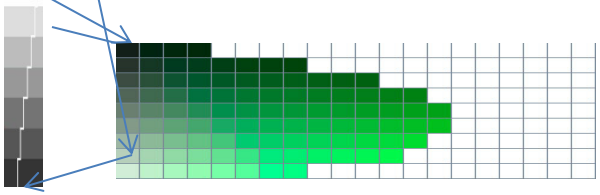


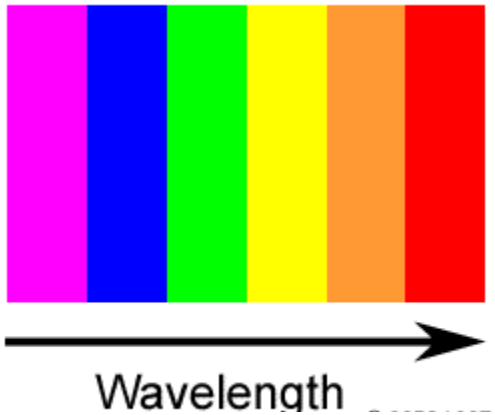


LOCATION1

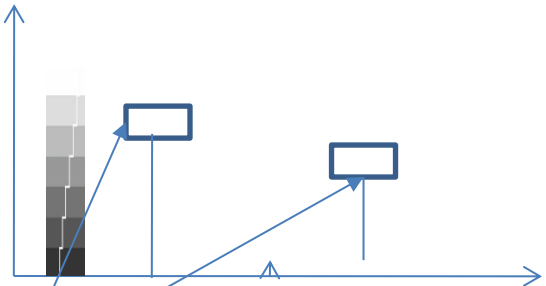
LOCATION 2



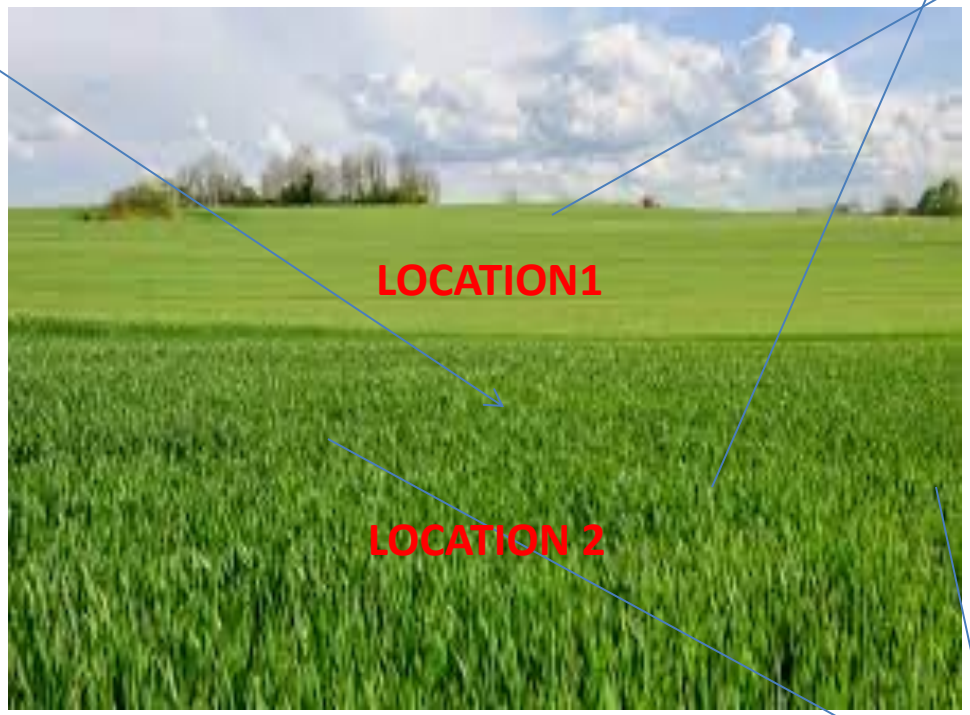


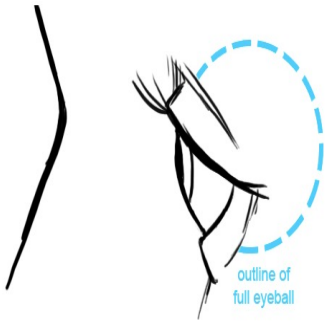


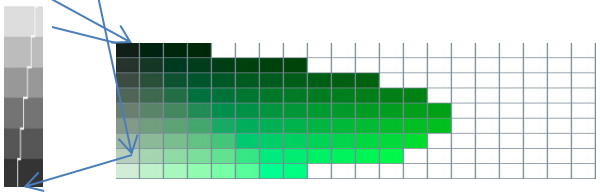
Green
Amplitude



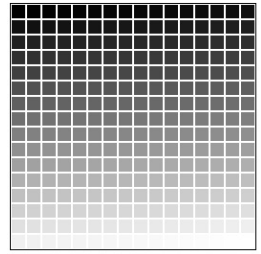
G

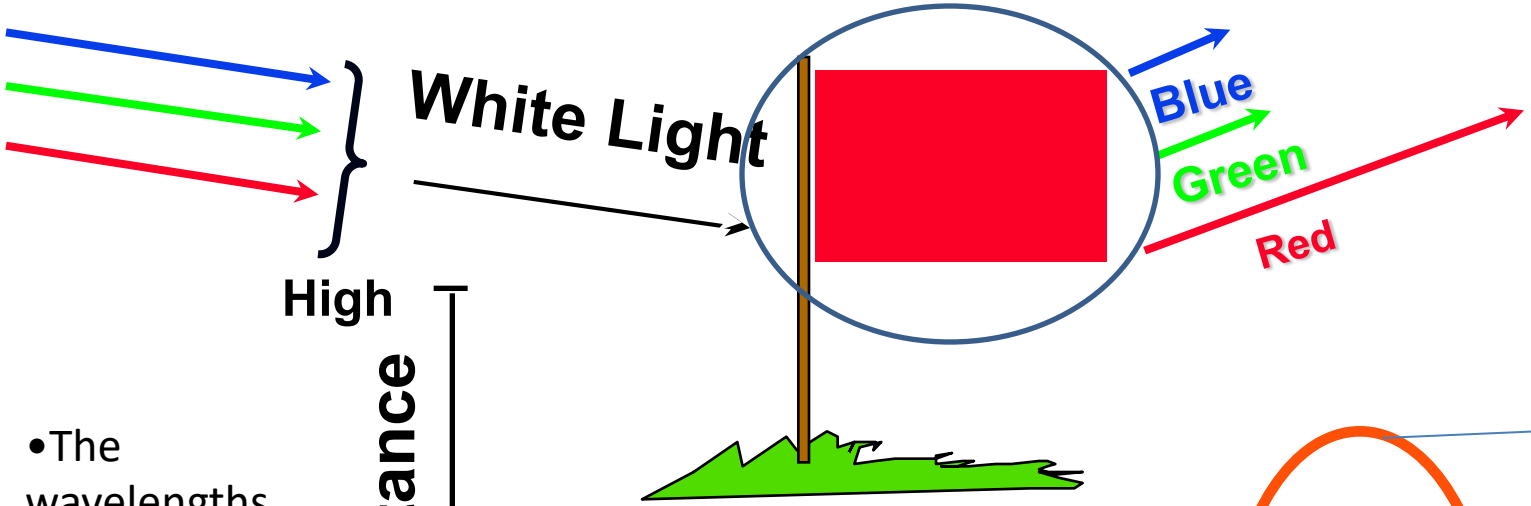




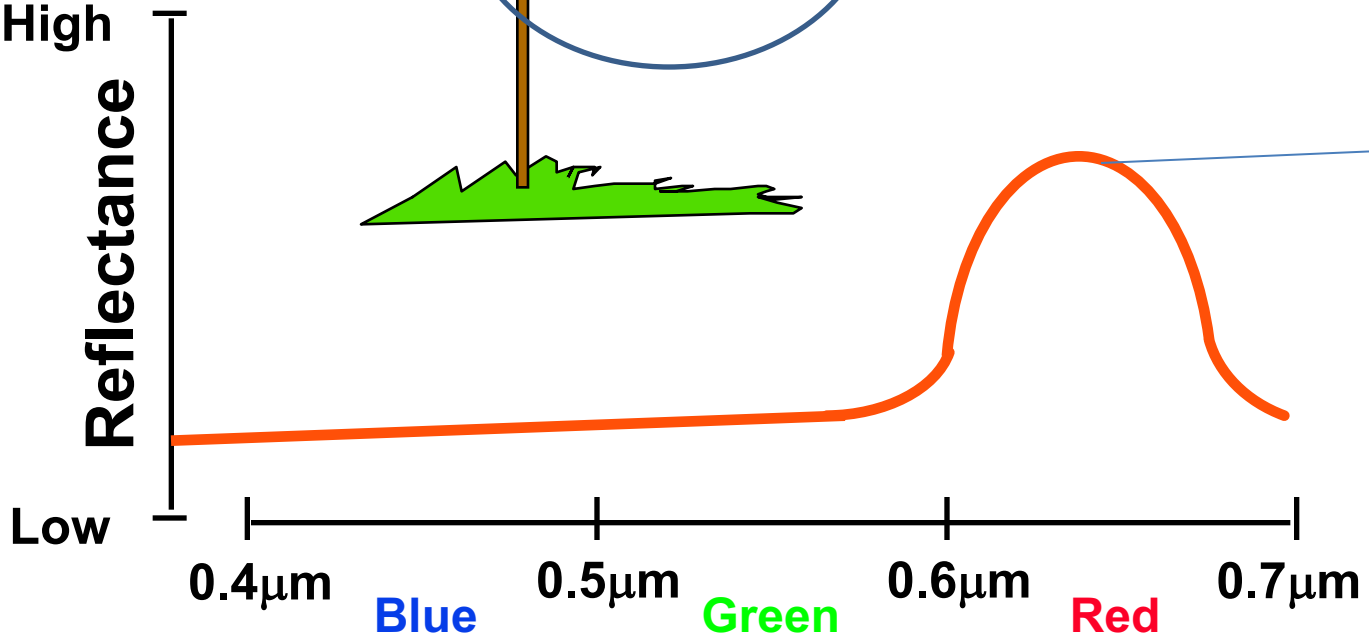


Reflectance Curve



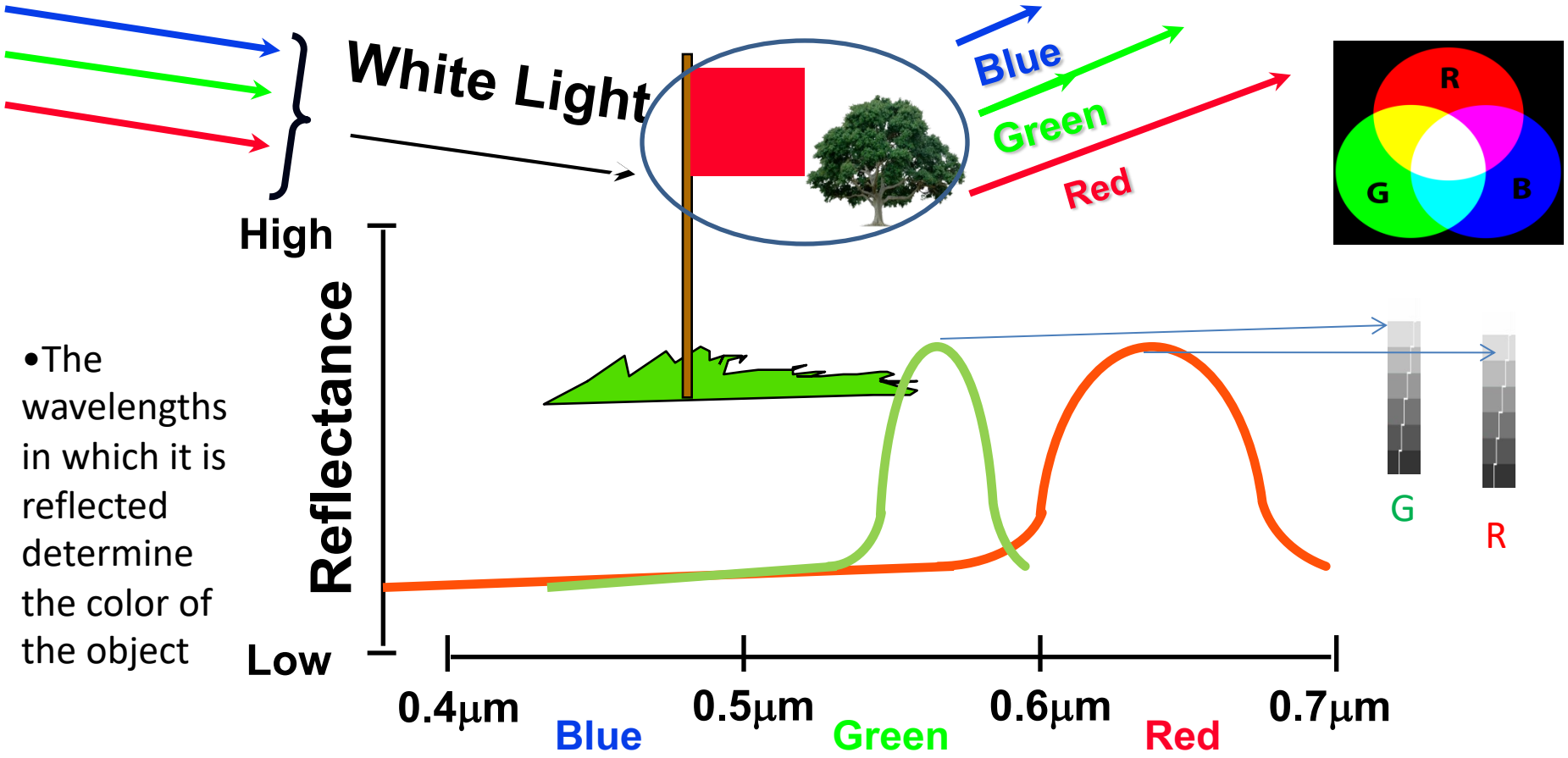


- The wavelengths in which it is reflected determine the color of the object



Source: Jarlath O'Neil-Dunne

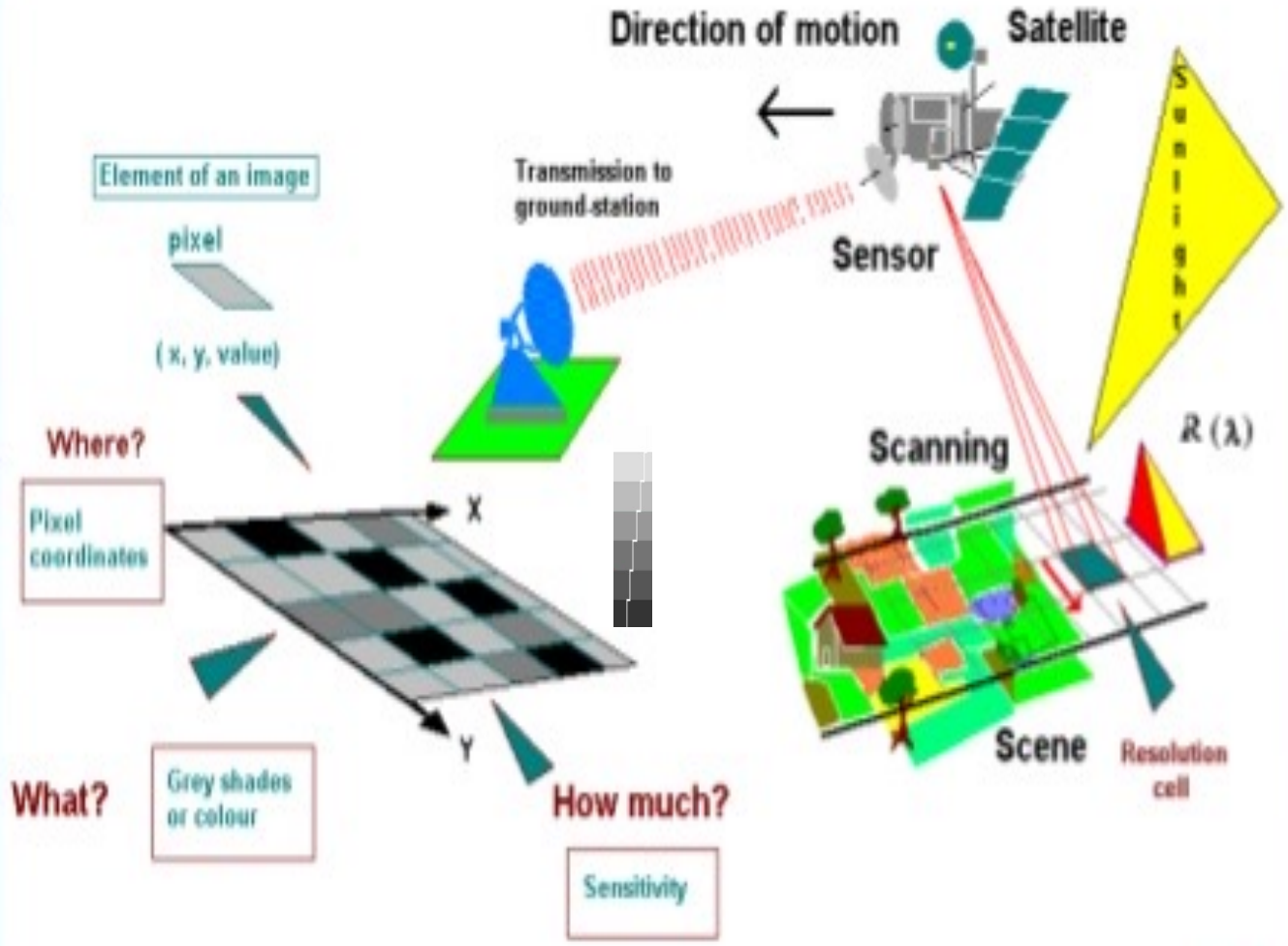
Reflectance Curve



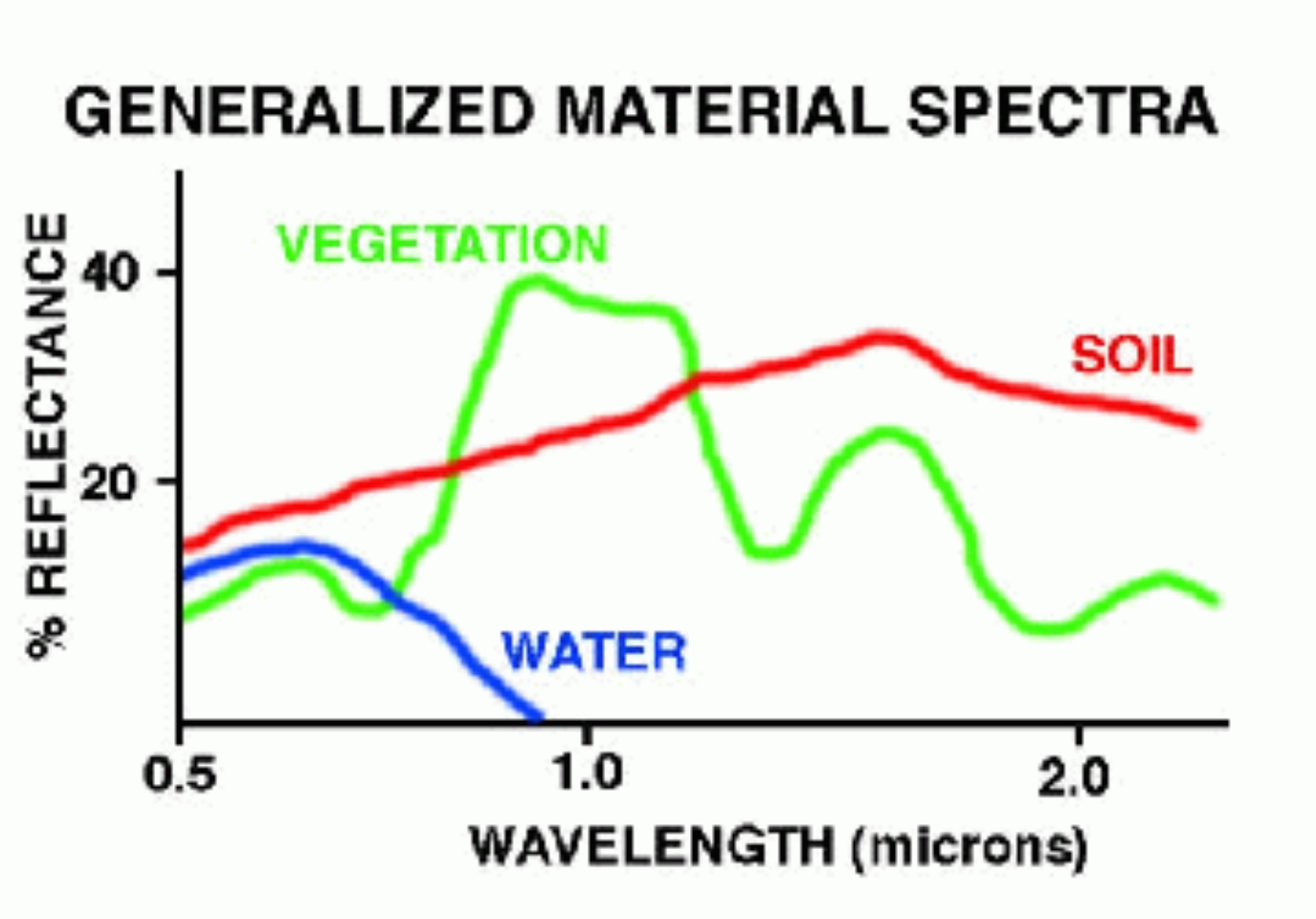
- The wavelengths in which it is reflected determine the color of the object

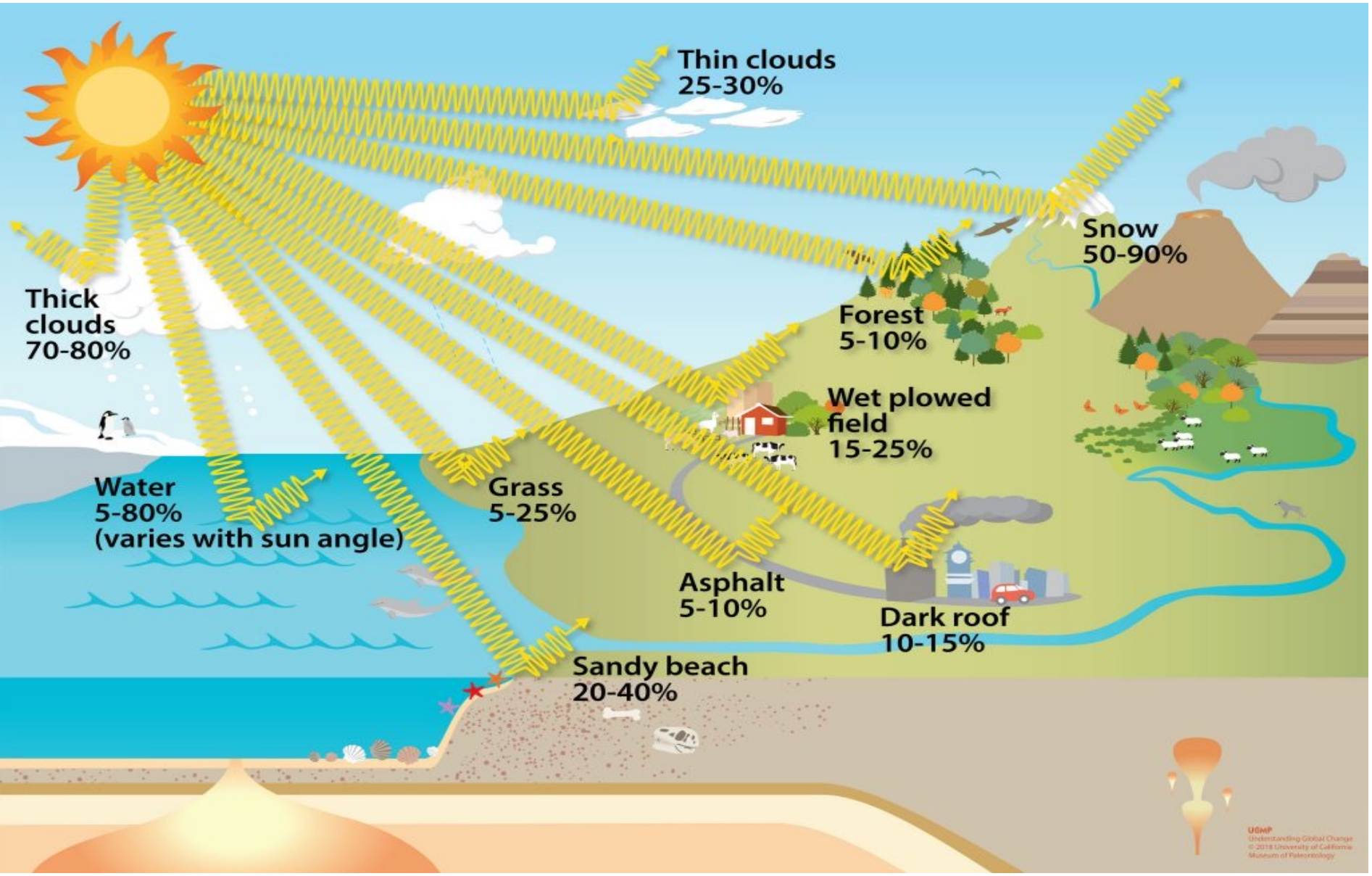
Source: Jarlath O'Neil-Dunne

Acquisition and reproduction of remotely sensed images



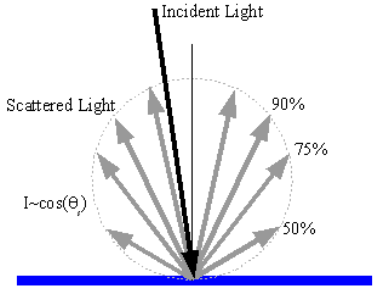
Spectral “Signatures”

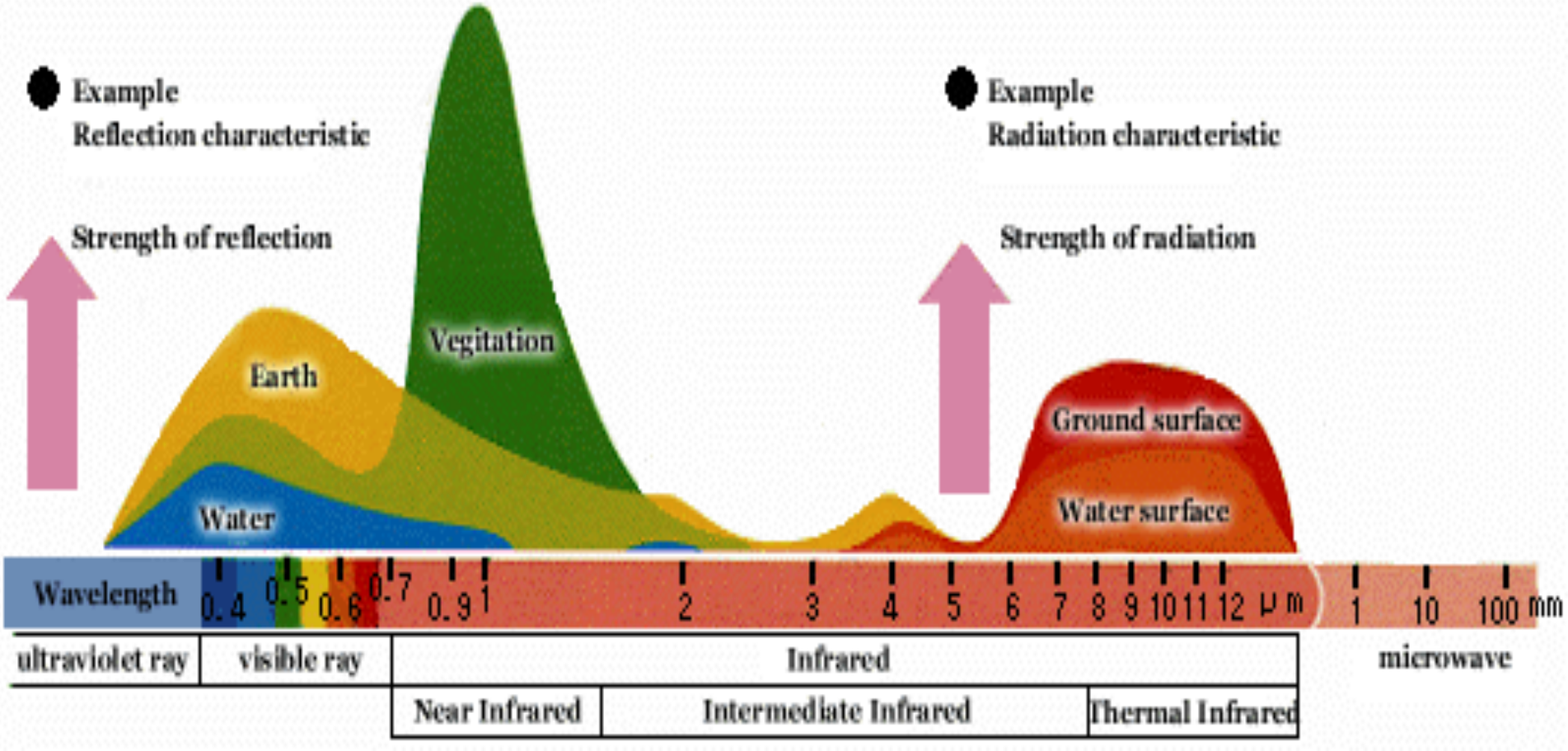


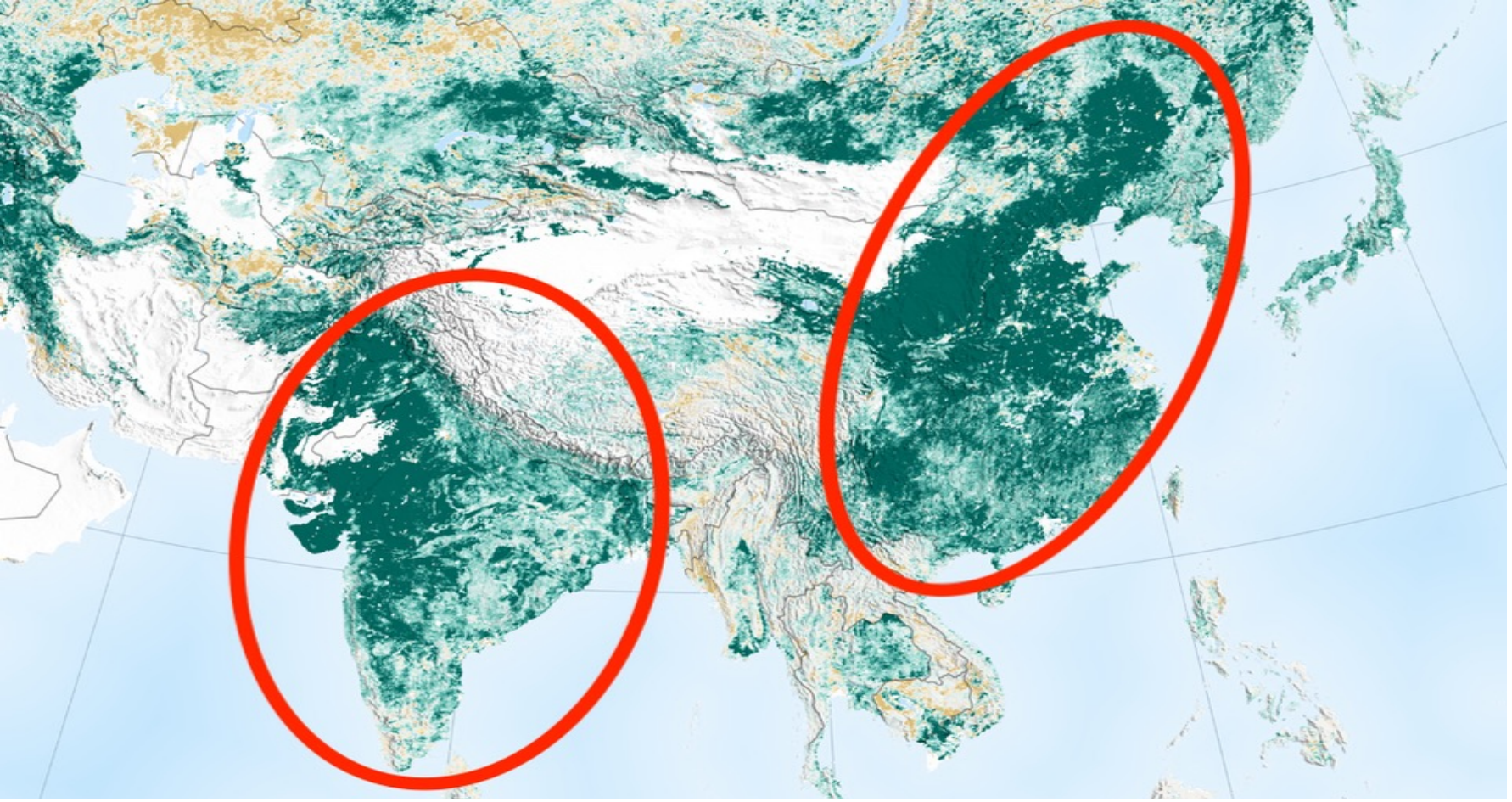


https://ugc.berkeley.edu/background-content/reflection-absorption-sunlight/

Distribution





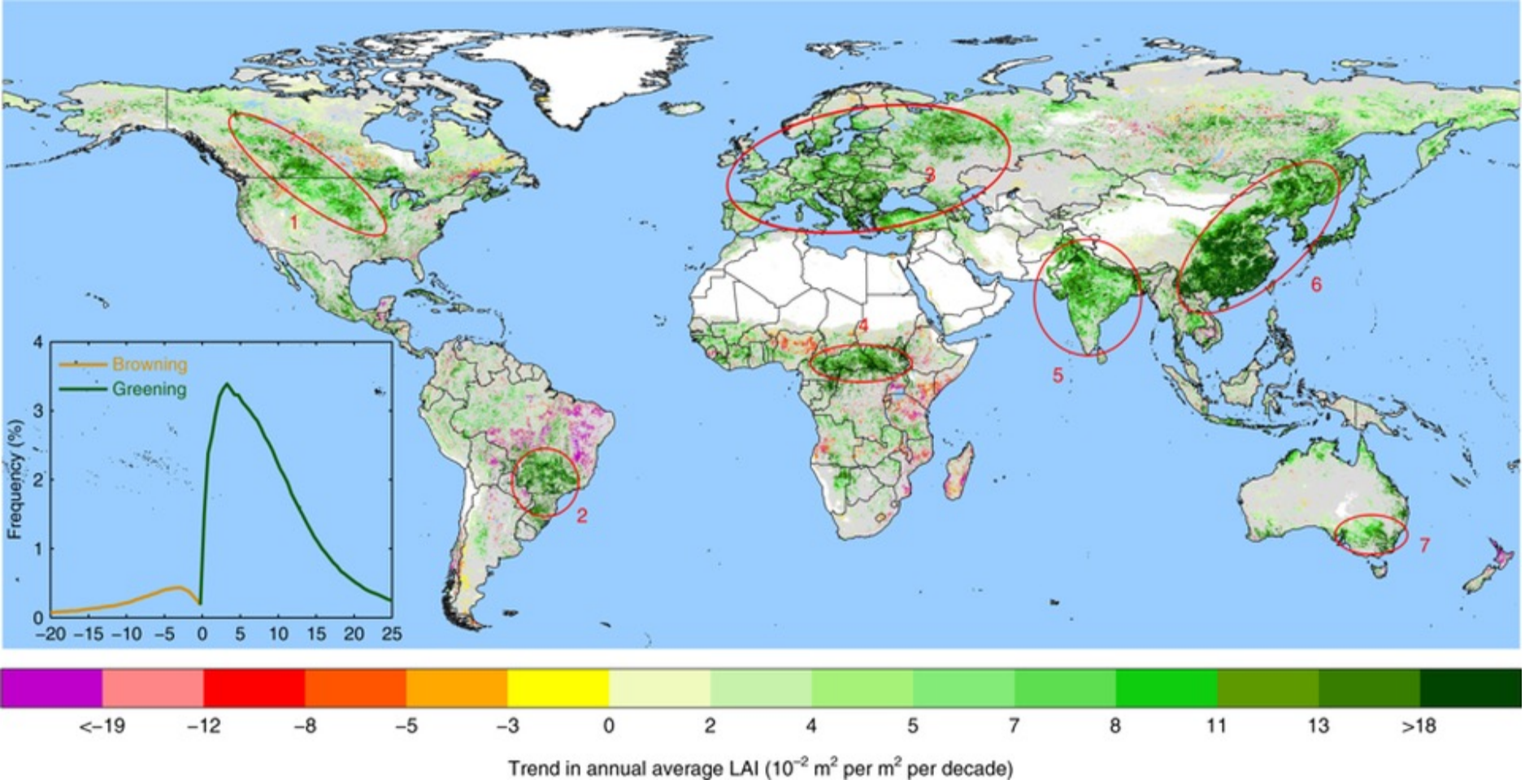


Greening of China and India

NASA

NASA has some good news, the world is a greener place today than it was 20 years ago.

https://www.forbes.com/sites/trevornace/2019/02/28/nasa-says-earth-is-greener-today-than-20-years-ago-thanks-to-china-india/?sh=4dfd8c6f6e13

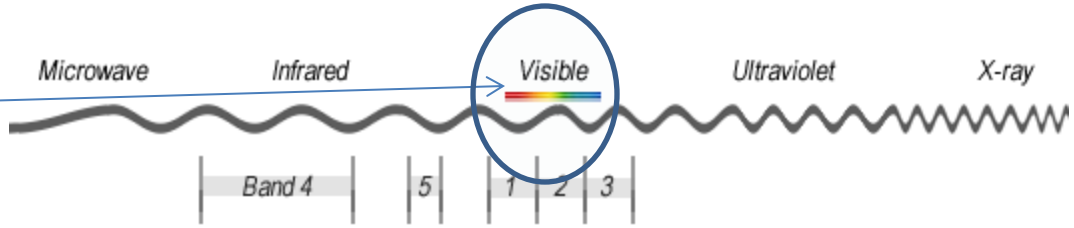

1
2
3
4
5
6
7
Browning
Greening
Frequency (%)
0
1
2
3
4
−20 −15 −10 −5 0 5 10 15 20 25
<−19
−12
−8
−5
−3
0
2
4
5
7
8
11
13
>18
Trend in annual average LAI (10^{-2} m^2 per m^2 per decade)

REMOTE SENING DATA COLLECTION METHODS

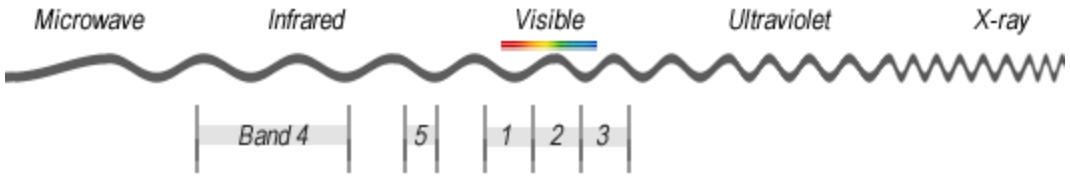
OPTICAL/IR REMOTE SENSING

- PANCHROMATIC
- MULTISPECTRAL
- HYPERSPECTRAL

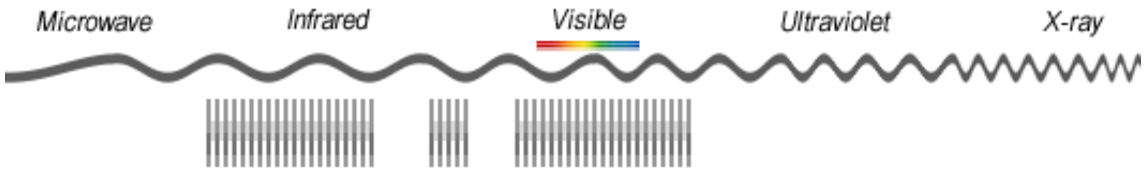
Panchromatic

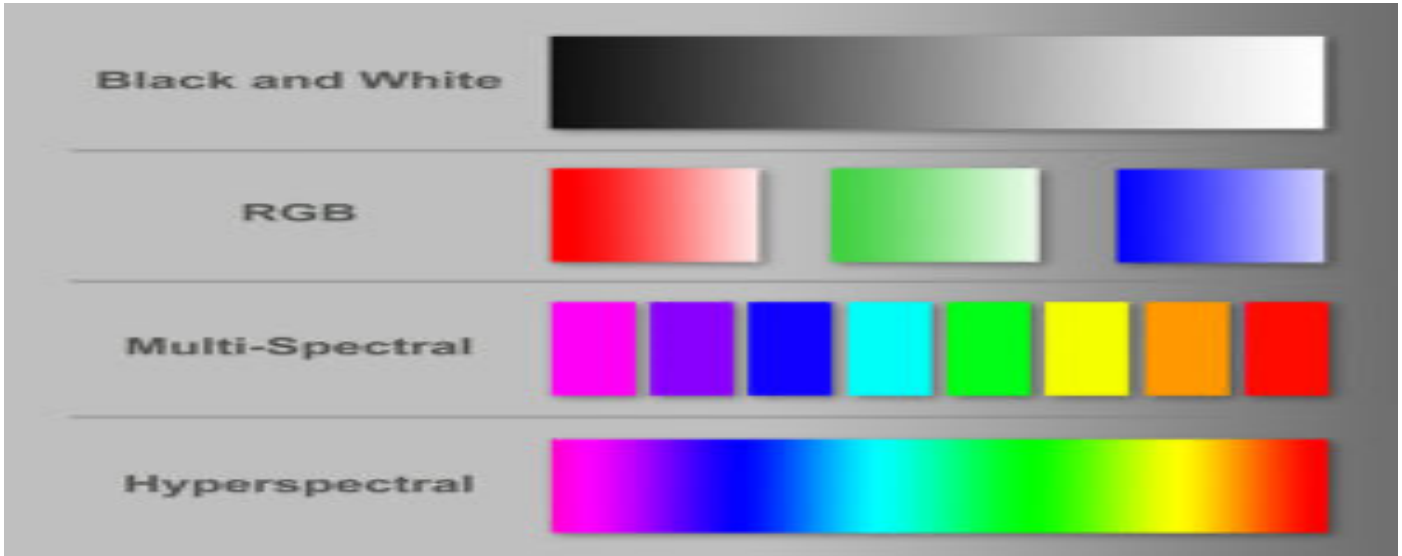


Multispectral



Hyperspectral



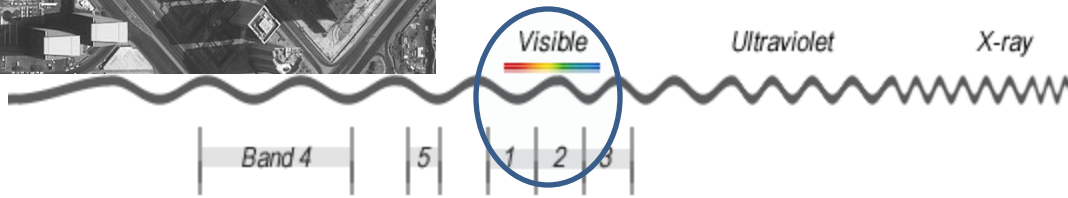


A panchromatic band (black and white band) is one band that usually contains a couple of hundred nanometers bandwidth. The bandwidth enables it to hold a high signal-noise, making the panchromatic data available at a high spatial resolution. This images can be gathered with a higher resolution since the spectral range give the smaller detectors allowance to be utilized while sustaining the high signal-noise ratio.

Advantage:
High SNR
High resolution

Cartosat-3 has a ground **resolution** of 0.25 m with
16 km swath
Doha

Cartosat-3



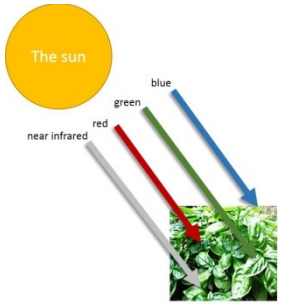
https://eos.com/panchromatic/

Pan Vs Multi

Spot 5 over Tor Vergata

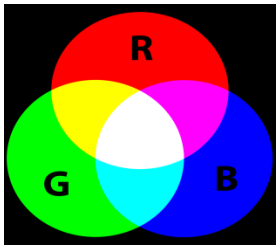
Pan Image

Multi-S Image



Display of Multispectral Image

- NATURAL color composite

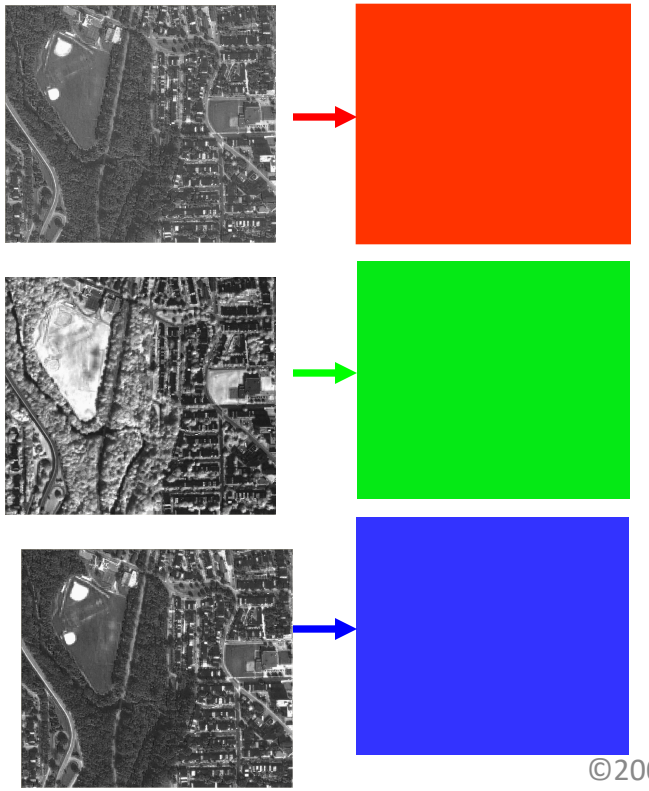


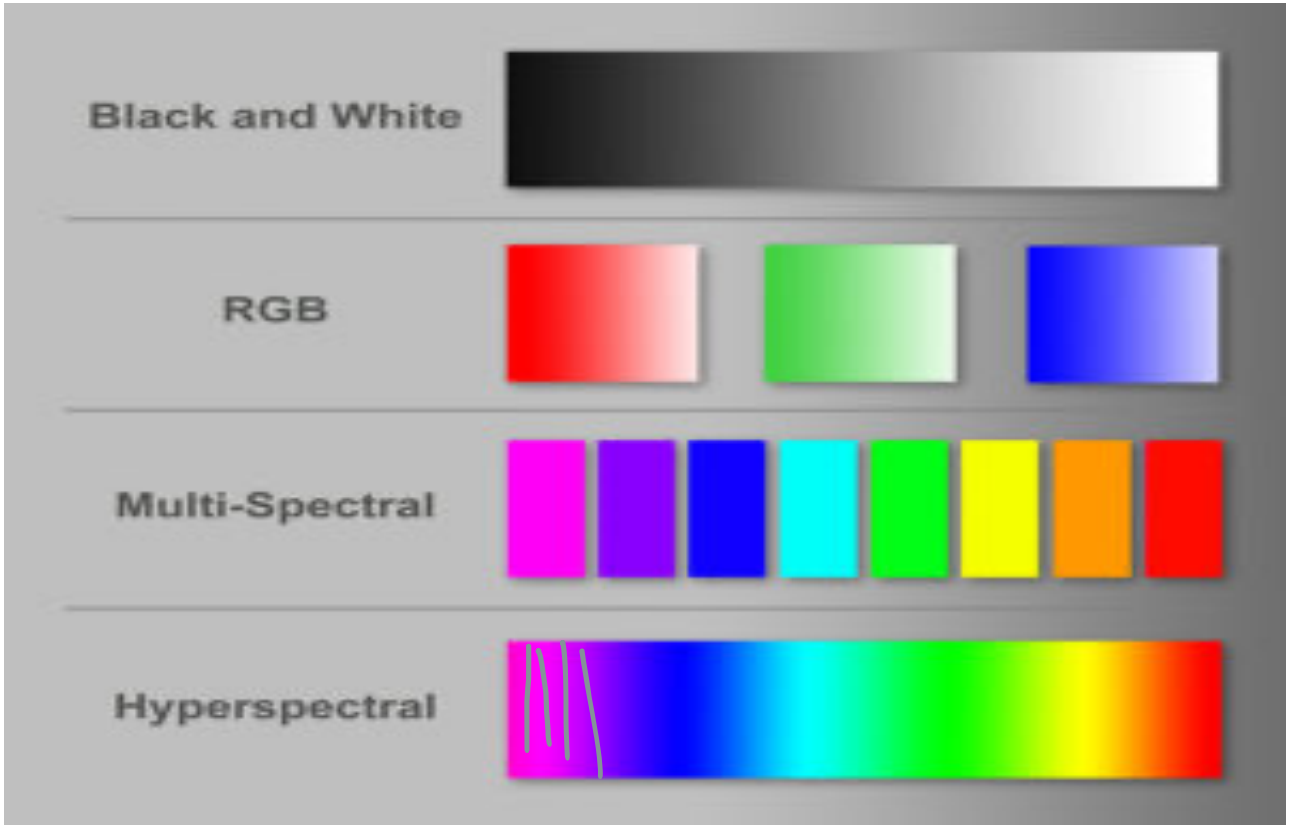
Bands Applied to color Resulting Image

Red

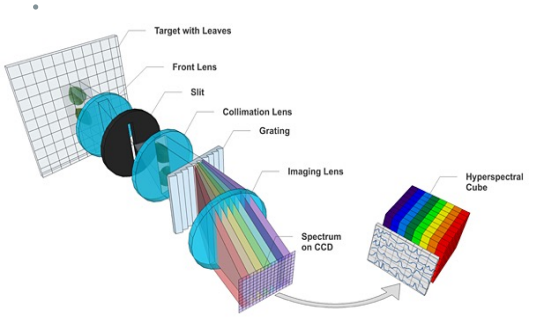
Green

Blue



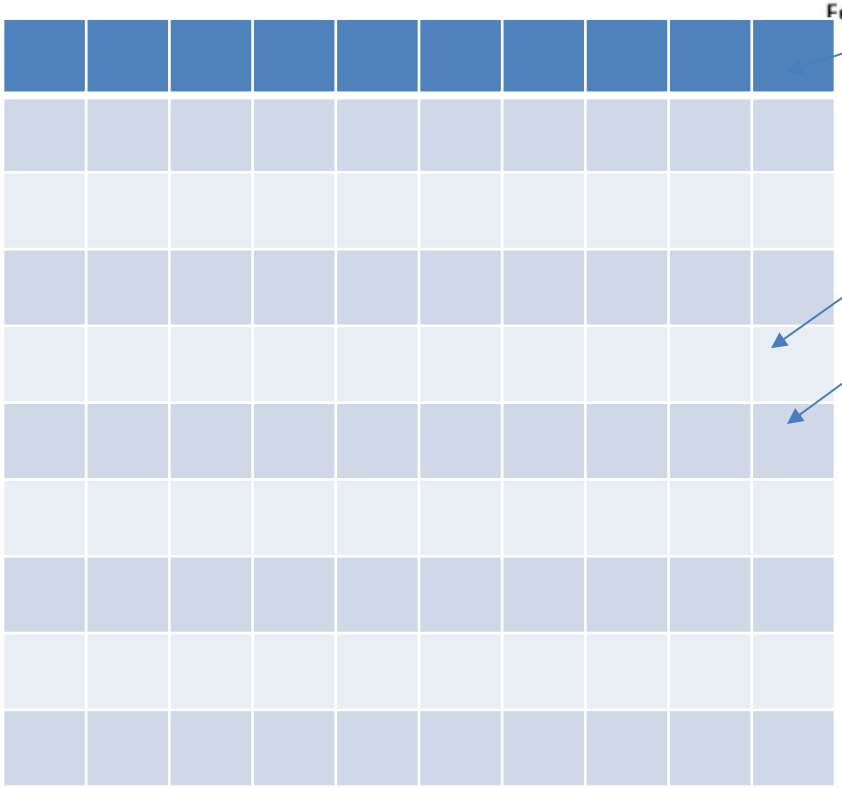

Black and White
RGB
Multi-Spectral
Hyperspectral

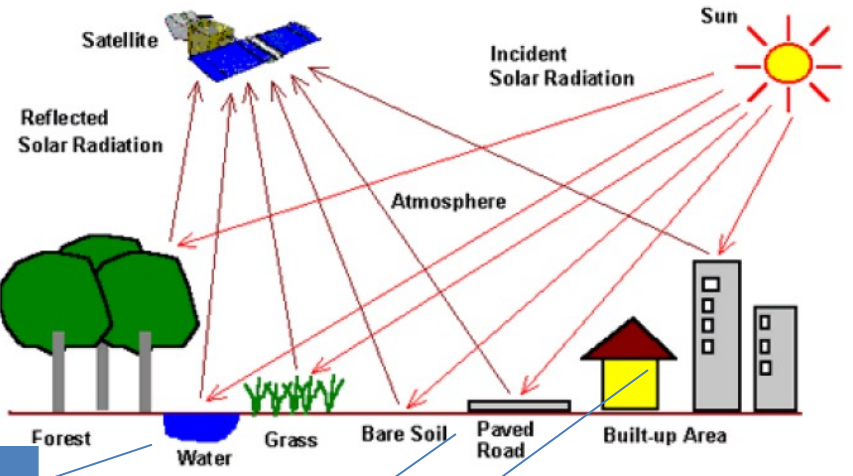

Panchromatic
Natural Color
False Color Infrared

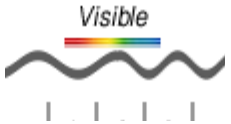

Target with Leaves
Front Lens
Slit
Collimation Lens
Grating
Imaging Lens
Spectrum on CCD
Hyperspectral Cube

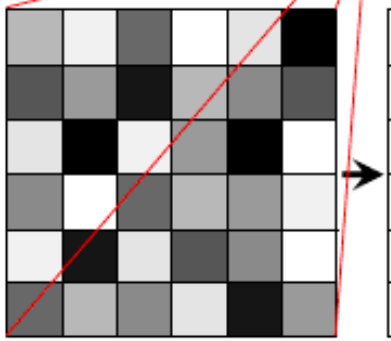
WHAT IS REMOTE SENSING DATA

A TWO DIMENSIONAL DISTRIBUTION OF REFLECTED ENERGY

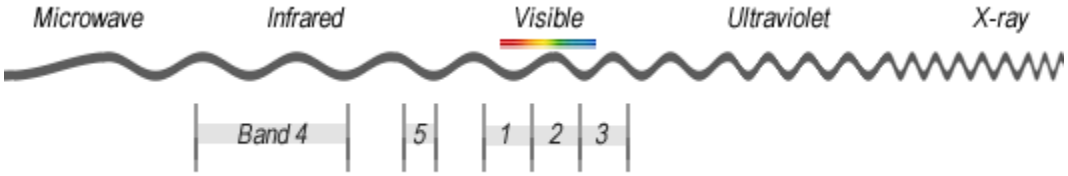


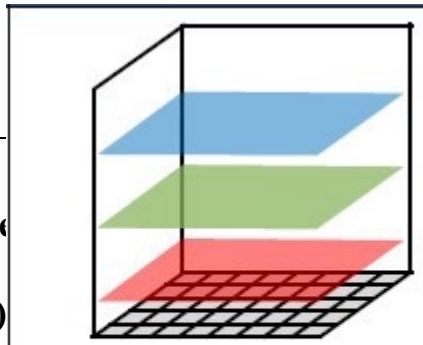


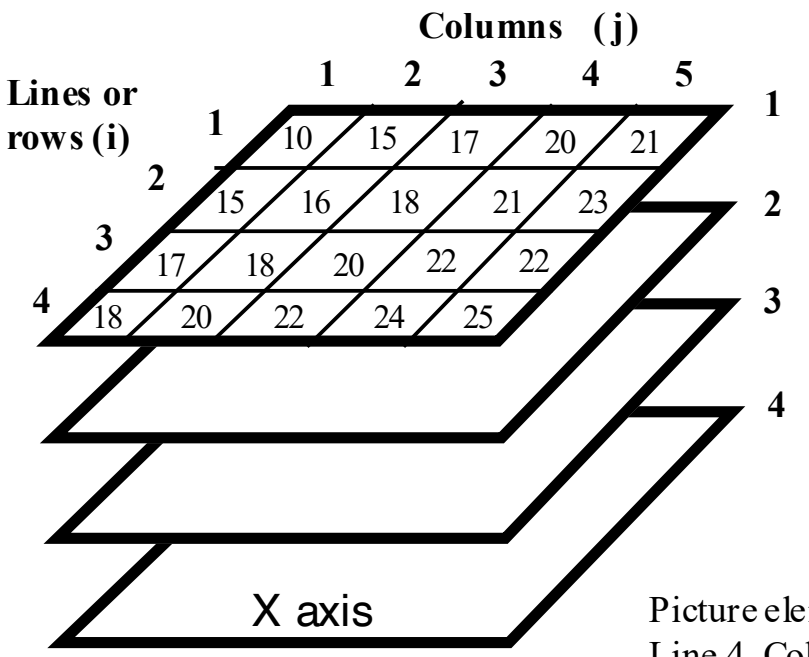




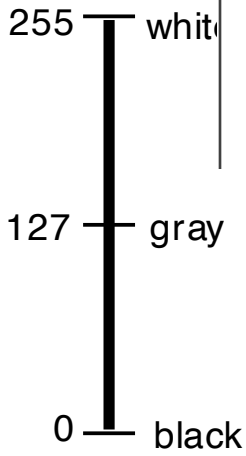
170	238	85	255	221	0
68	136	17	170	119	68
221	0	238	136	0	255
119	255	85	170	136	238
238	17	221	68	119	255
85	170	119	221	17	136



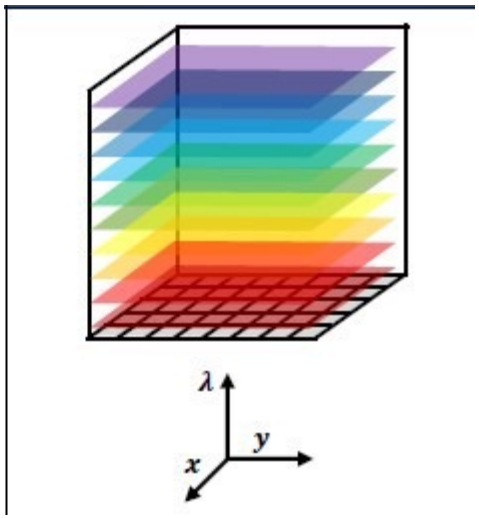


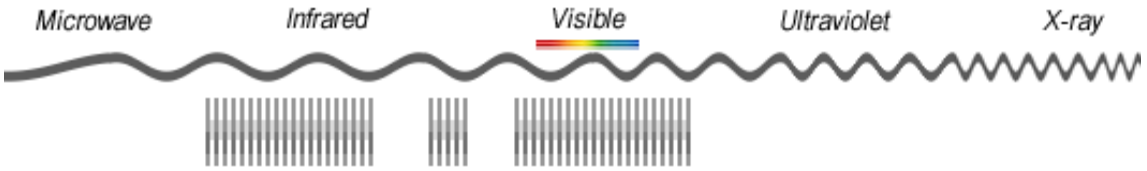


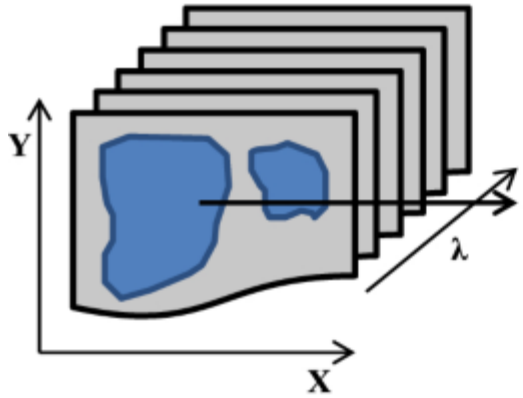
Bands (k)



Picture element (pixel) at location Line 4, Column 4, in Band 1 has a Brightness Value of 24, i.e., $BV_{4,4,1} = 24$.







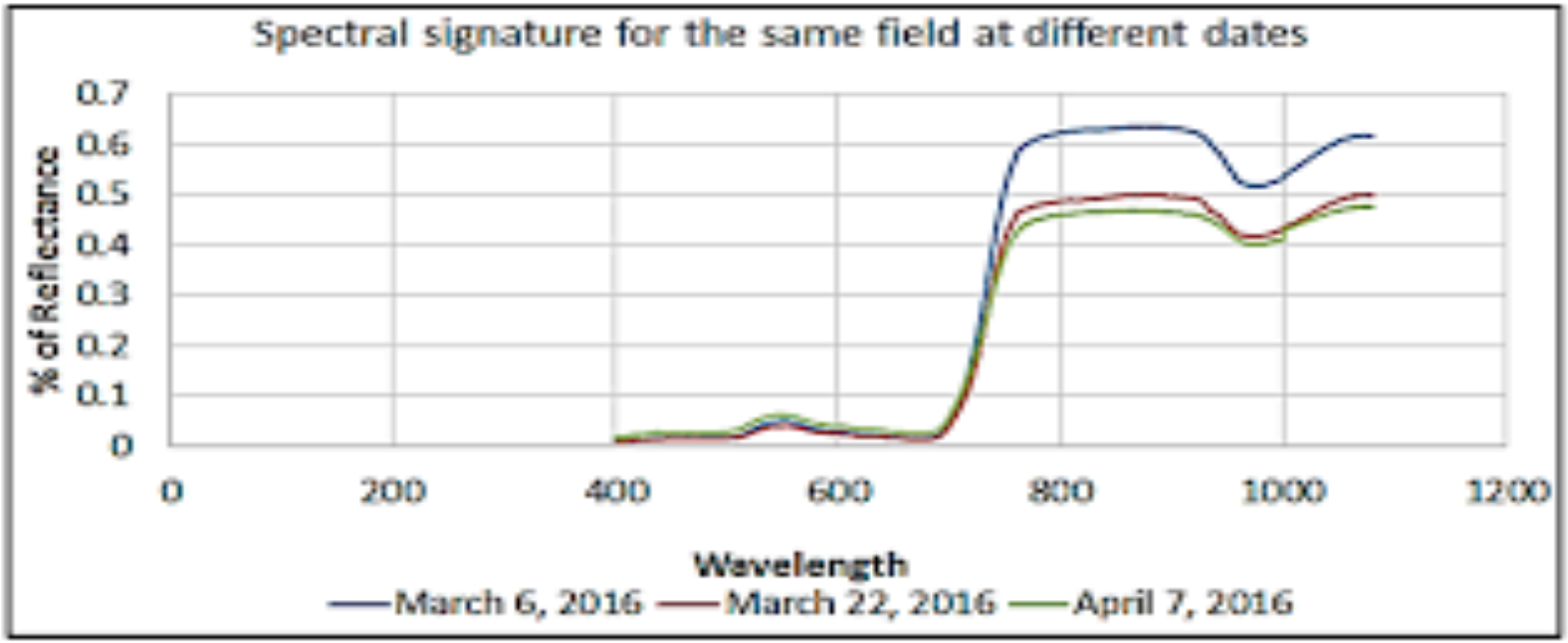
Pixel Spectrum at (X_i, Y_j)

Spatial Dimension (X_i, Y_j)

Spectral Dimension (λ_k)

WHAT IS SPECTRAL SIGNATURE

Different surface types such as water, bare ground and vegetation reflect radiation differently in various channels. The radiation reflected as a function of the wavelength is called the spectral signature of the surface.



QUESTION BANK

EXPLAIN :

PACHROMAIC , COLOR , MULTISPECTRAL AND HYPERSPECTRAL REMOTE SENSING

What do you mean by SPECTRAL SIGNAURE