# Hyperspectral remote sensing (spectroscopy)

## Fundamentals of spectroscopy

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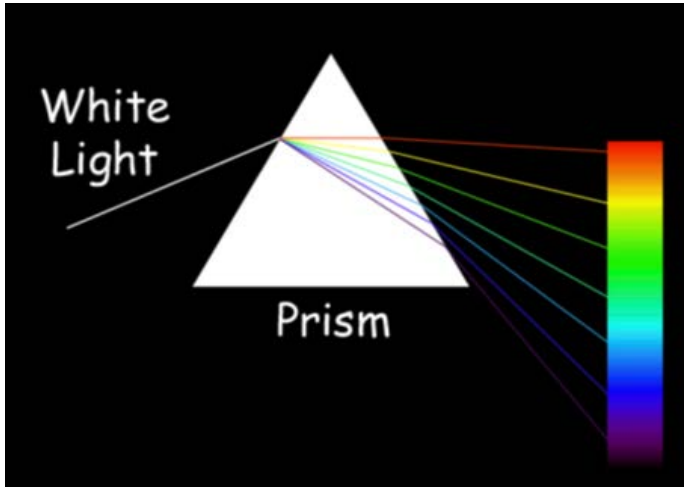
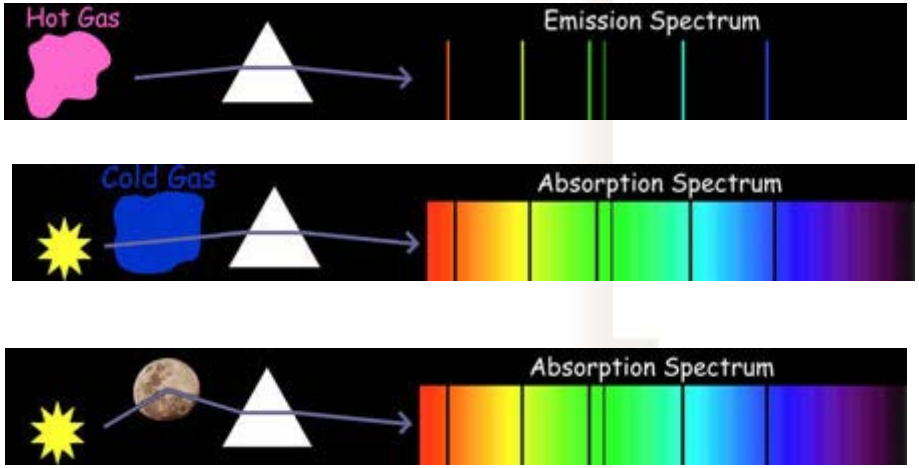
# Spectroscopy

**Spectroscopy** is a scientific measurement technique. It measures light that is emitted, absorbed, or scattered by materials and can be used to study, identify and quantify those materials.

**Continuous spectrum**: a sample of light broken up of all wavelengths



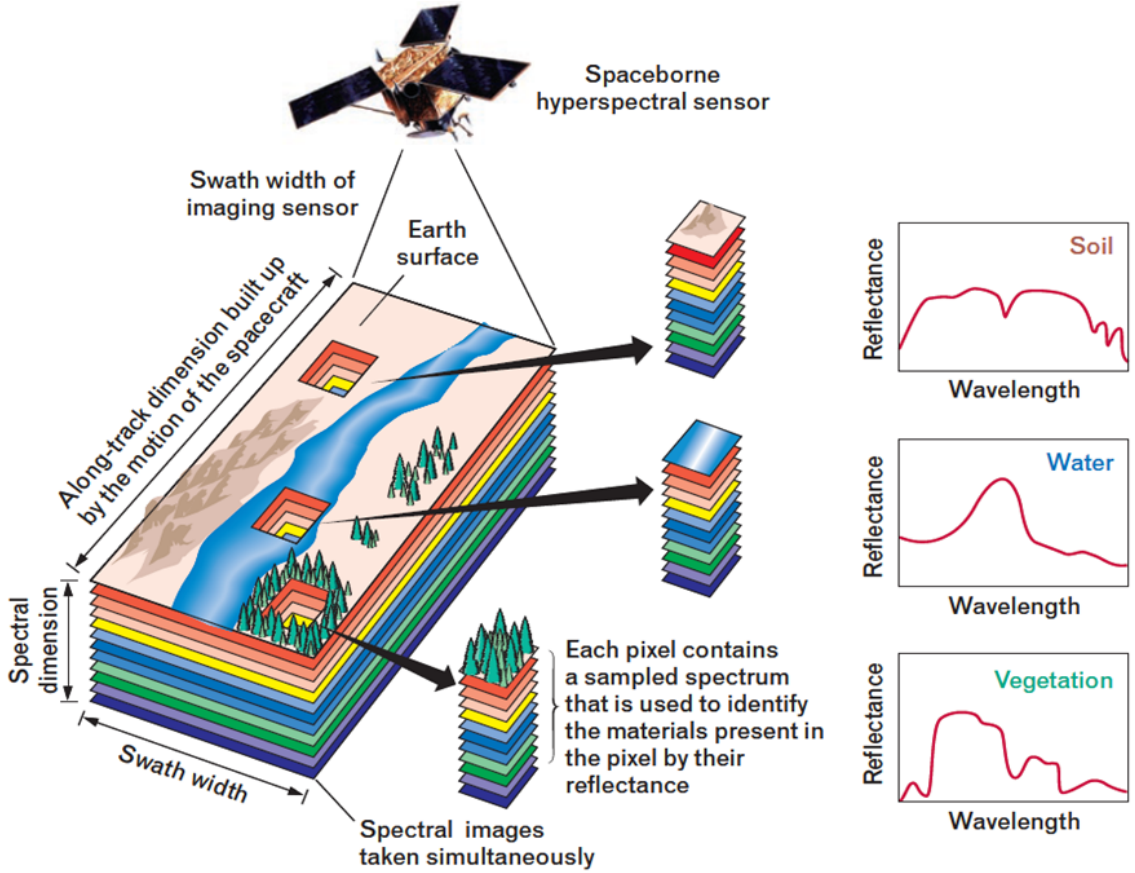




*From Wiggins*

*Spectroscopy is the study of light as a function of wavelength that has been emitted, reflected or scattered from a solid, liquid, or gas (Clark, 1999)*

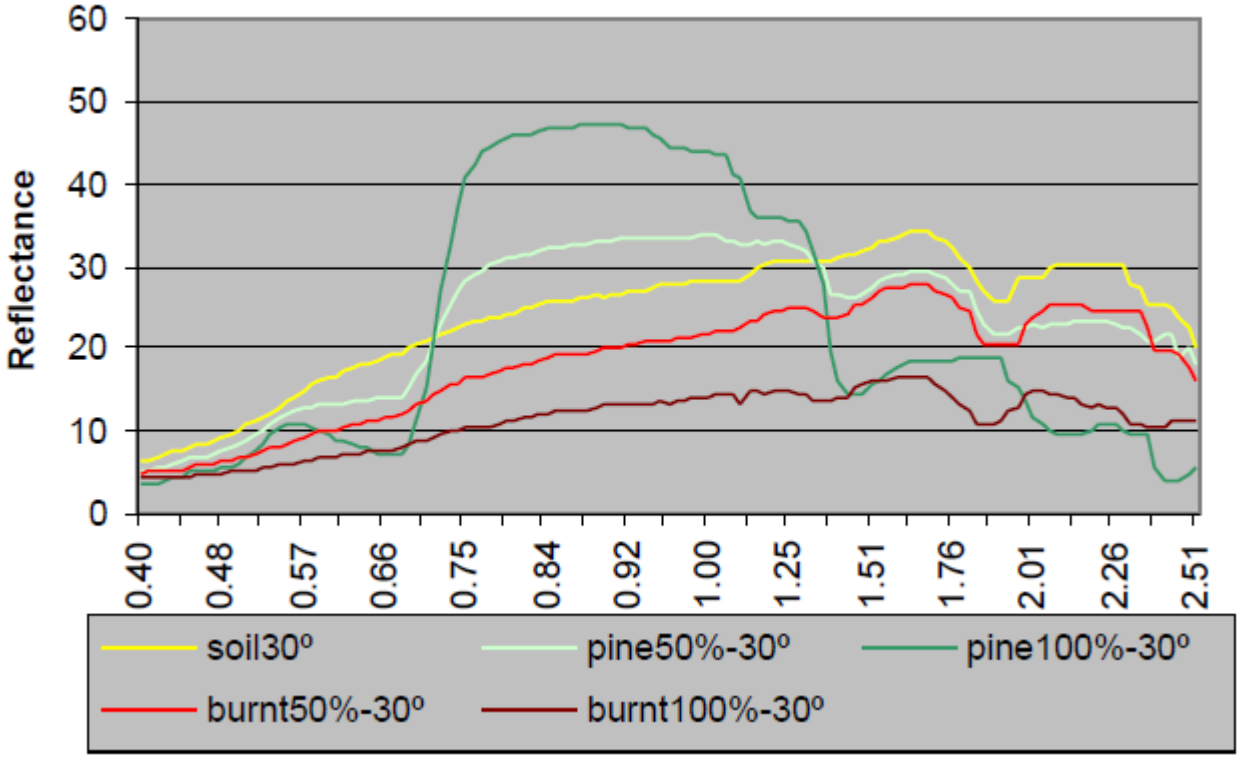
# Imaging Spectroscopy (Hyperspectral Imaging)

The main objective of **imaging spectroscopy (hyperspectral imaging)** is to measure the spectral signatures and/or chemical composition of all features within the sensor's field of view. (*from Elowitz*)



# Imaging Spectroscopy (Hyperspectral Imaging)

The **spectrum**: plot of wavelength versus radiance or reflectance
The **spectral signature** can be used to identify and characterize a particular feature, so it is a “fingerprint“ (*from Elowitz*)




ultraviolet (UV): 0.001 -0.4 µm

visible: 0.4 - 0.7 µm

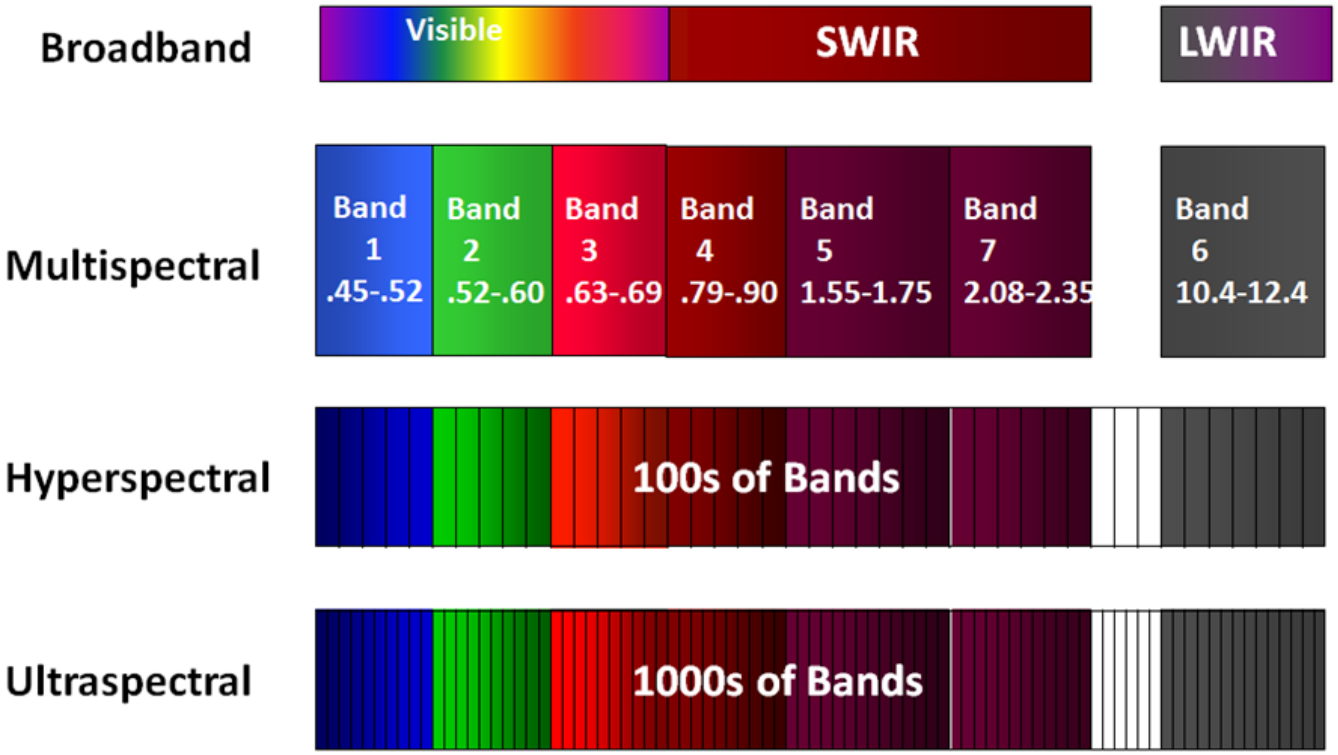
near-infrared (NIR): 0.7-3.0 µm

mid-infrared (MIR): 3.0-30 µm

far infrared (FIR): 30 µm -1 mm

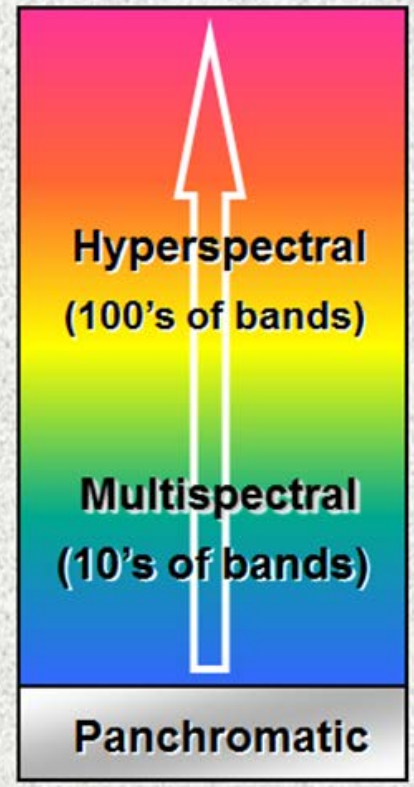
(from Martin 2012)

# Hyperspectral vs Multispectral




(*from Elowitz*)

# Hyperspectral vs Multispectral




**Quantification**: Determines the abundance of materials.

**Characterization**: Determines variability of identified material (e.g. wet/dry sand, soil particle size effects).

**Identification**: Determines the unique identity of the foregoing generic categories (i.e. material identification).

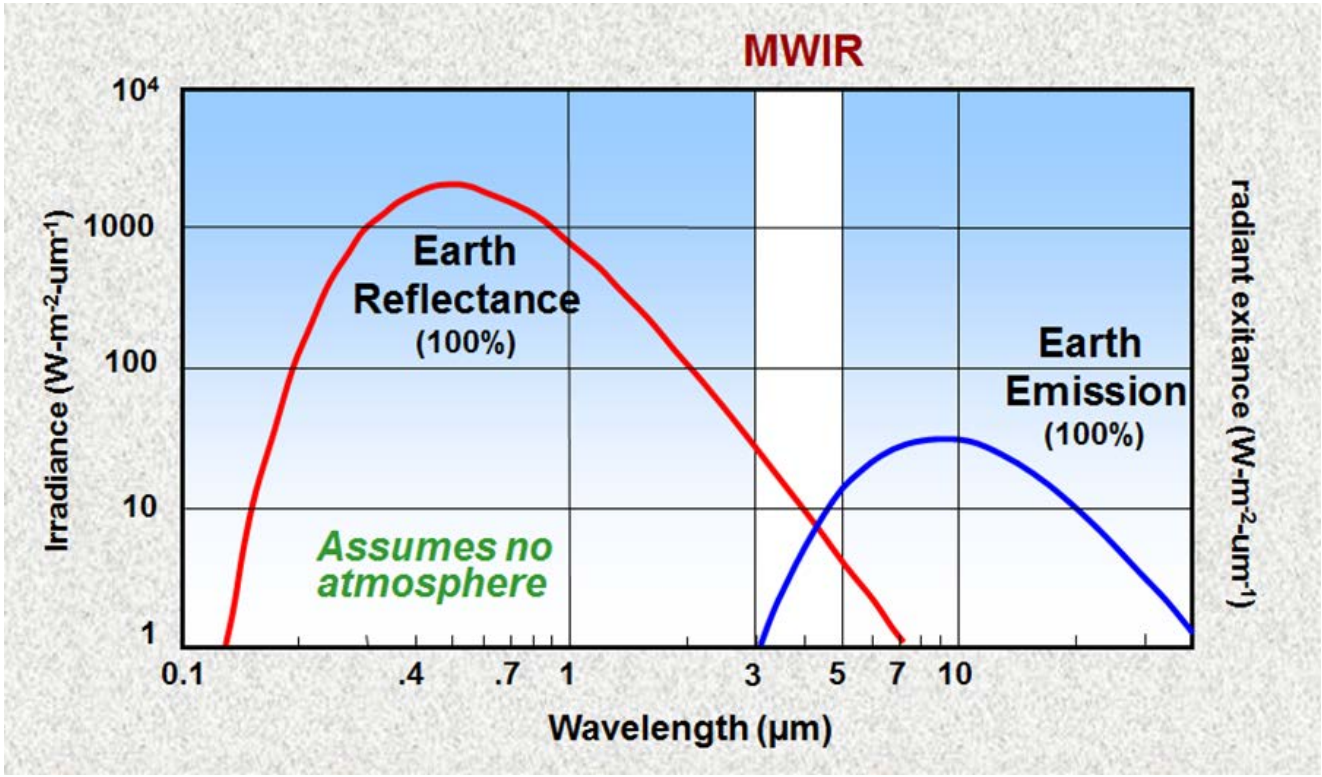
**Discrimination**: Determines generic categories of the foregoing classes.

**Classification**: Separates materials into spectrally similar groups.

**Detection**: Determines the presence of materials, objects, activities, or events.

(*from Elowitz; and Plaza, 2009*)

# ¿Which wavelengths?

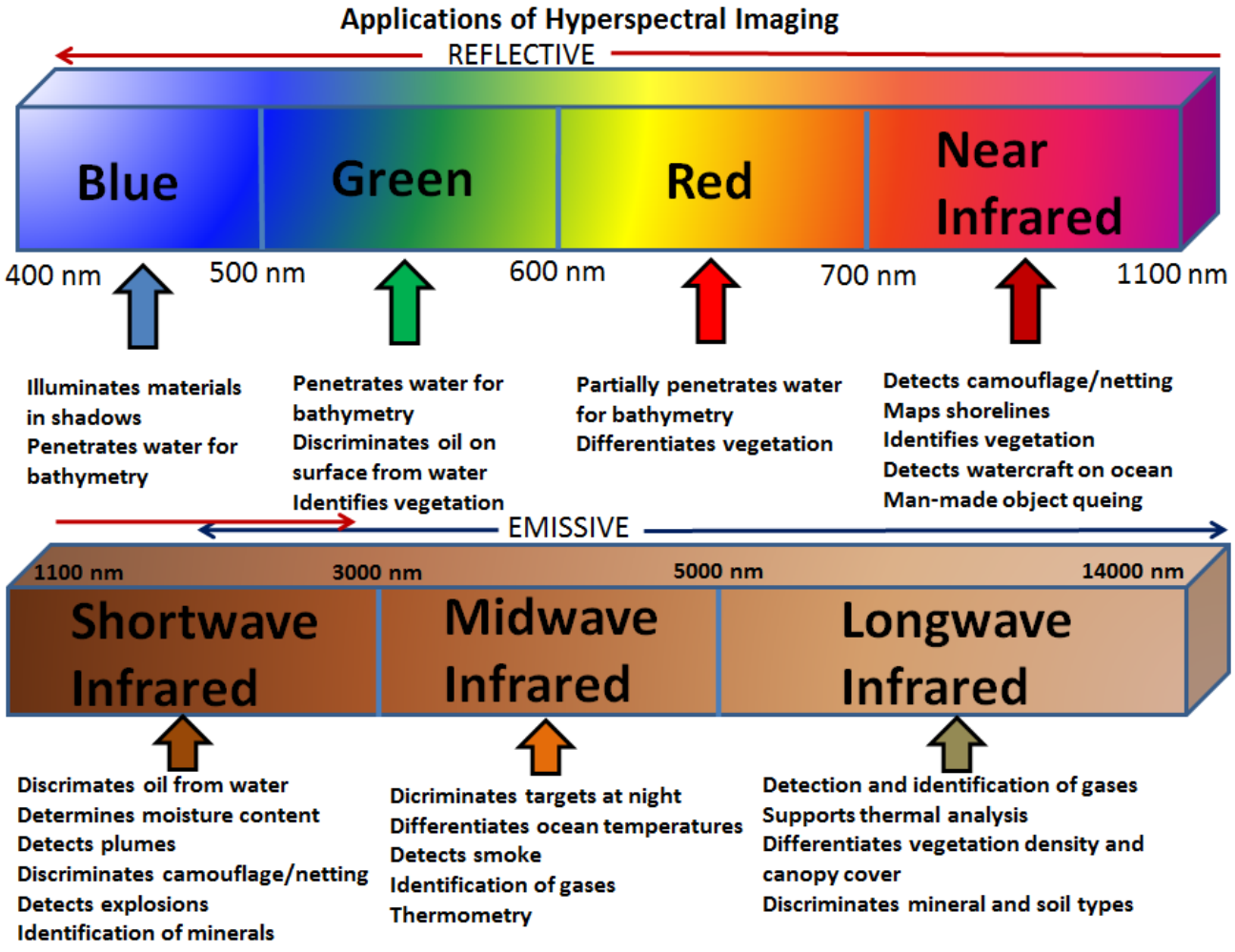



0.4-1.0 μm: VNIR (visible-near-infrared)
1.0-2.5-μm: SWIR (short-wave infrared)

8-14 μm: longwave-infrared

**3-5 μm: mid-infrared**
(*from Elowitz*)

# Applications



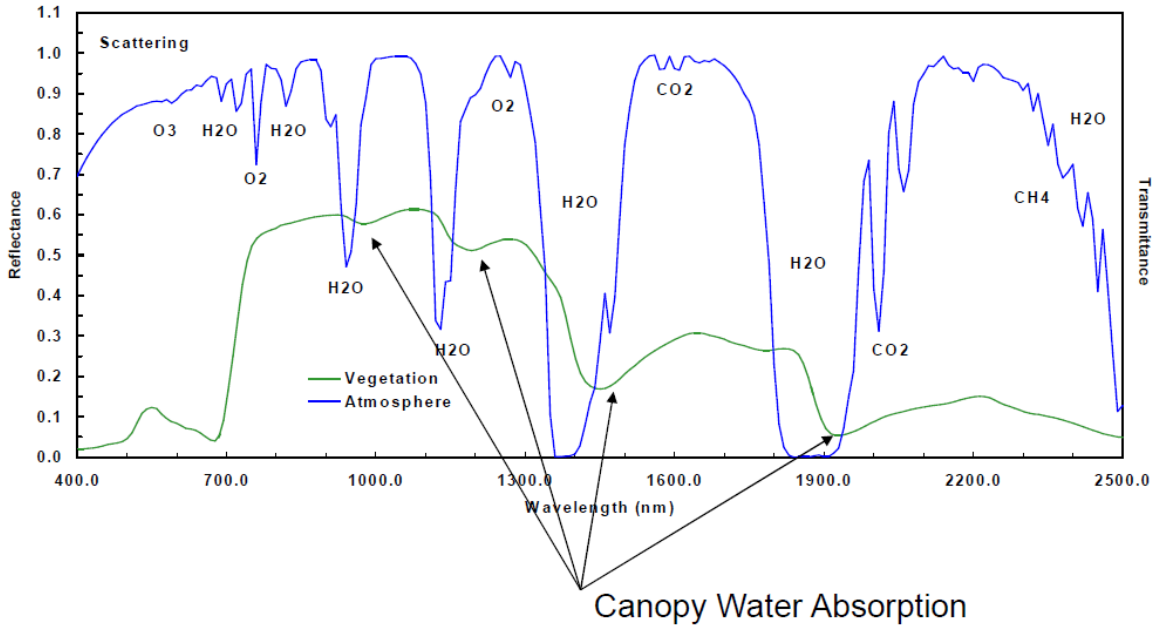

(*from Elowitz*)

# Conclusion

**Spectroscopy** is the study of light as a function of wavelength that has been emitted, reflected or scattered from a solid, liquid, or gas

The **spectral signature** can be used to identify and characterize a particular feature, so it is a “fingerprint“

**Spectral range:** 0.4-1.0 µm: **VNIR** (visible-near-infrared) 1.0-2.5-µm: **SWIR** (short-wave infrared)



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Don Wiggins, Maryland Space Grant Summer Intern, Chemistry Teacher, Governor Thomas Johnson High School, Frederick, MD
Graphics designed by Tim Cline, University of Maryland
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