BHARATHIDASAN UNIVERSITY

Tiruchirappalli - 620 024
Tamil Nadu, India

Programme : 6 year Integrated M.Tech in Geological Technology and Geoinformatics

Course title : Principles of Remote Sensing
Course code : MTGT 0304

UNIT - I

Principles of Remote Sensing

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What is Remote Sensing????

Observing or measuring things from a distance

In its broadest definition, remote sensing means collecting information about an object, area or a phenomenon without being in direct physical contact with it: learning without touching.

The most familiar kind of remote sensing is the use of our eyes to detect light. We also use remote sensing when we hear, and when we feel heat that radiates from a warm object.

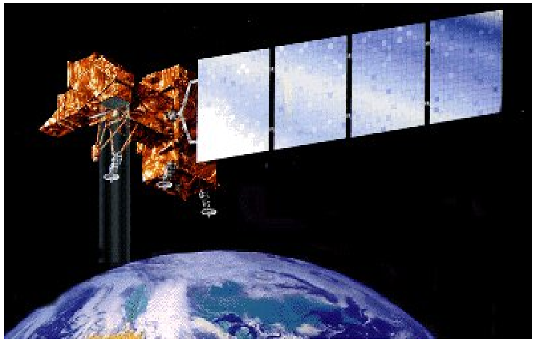
How Remote Sensing is Useful????

It enables us to study the surrounding world that would otherwise be beyond our capability, across great distances and at wavelengths of light invisible to us.

What Can We Study with Remote Sensing?

Land, air, water, rocks, living things, ice, snow etc.

For example:



- Climate change and its effects
- Productivity of farm lands
- How human activities change the earth
- Landforms we can not see from the ground
- Photosynthesis on land and in the ocean
- Air quality: chemicals and particles (aerosols)
- The extent of natural hazards such as volcanoes, floods, and drought
- Shifting ecosystem boundaries: deserts, forests, and wetlands

Very fast evolution due to technological advances (detectors, rockets, computers, :-)

What you learn today will be obsolete in ≈ 6 years :-(

Remote Sensing Gives Us the Synoptic View

Minamisanriku Area, Japan

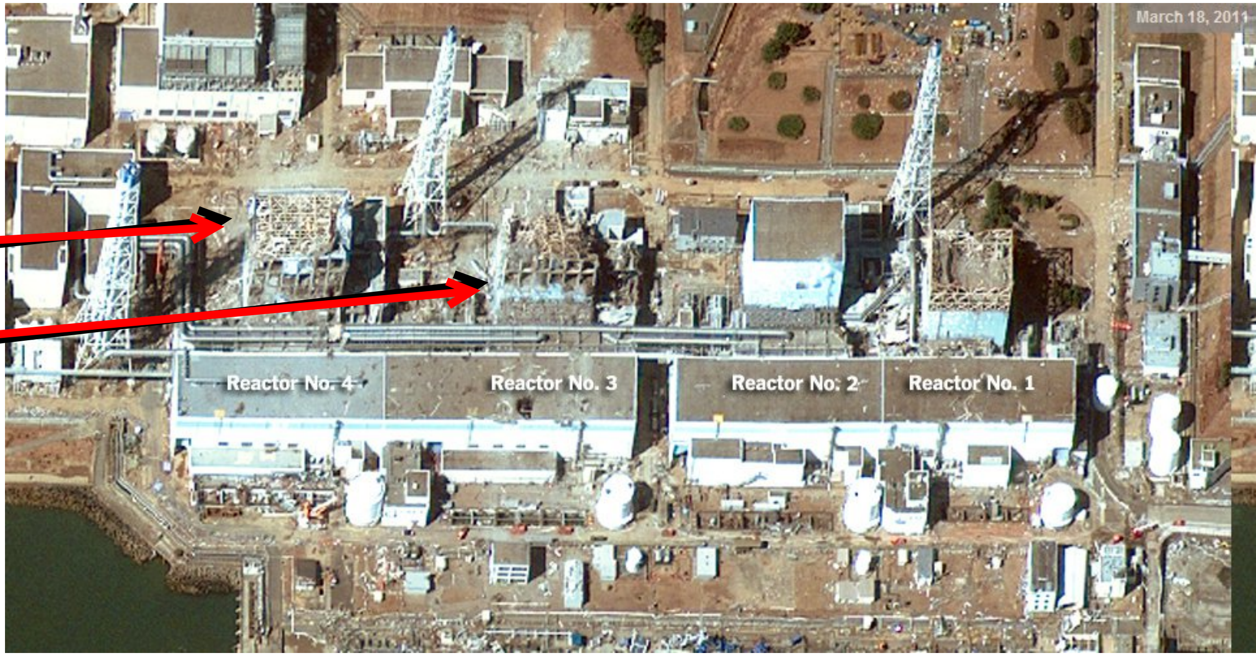
Before the Earthquake and Tsunami in Nov.2009

The same area after the onslaught of Earthquake and Tsunami in March 2011

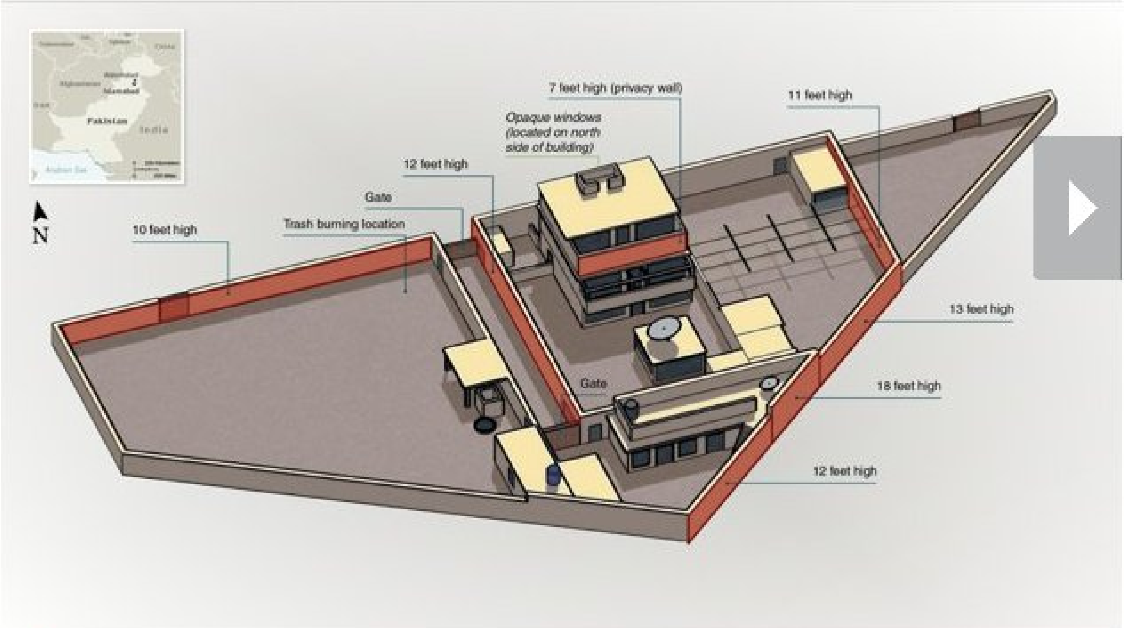
Source – Geoeye Satellite Image

Fukushima Daiichi Nuclear Plant

Damaged Nuclear Reactors



Satellite Image draped over Digital Elevation Model (DEM)



Associated Press

Mon, May 2, 2011

Satellite Image view of Osama's Mansion at Abbottabad, Pakistan

Remote sensing Images are used every day by:

- Archaeologists searching for ancient ruins
- Mapmakers / Surveyors
- Relief workers when there is an earthquake, flood, or volcanic eruption
- Urban planners for micro level planning
- Geologists to find minerals, oil, groundwater etc.
- Agronomists to forecast yield or assess insect damage
- Weather forecasters and climate researchers
- The fishing industry to locate the best areas for fishing
- Military reconnaissance experts
- Astronomers

There are hundreds for uses of Remote Sensing. New ones are being developed every year!!!!

How does Remote Sensing work?

"By sensing and measuring radiation "

Everything in nature radiates!

You and everything around you!

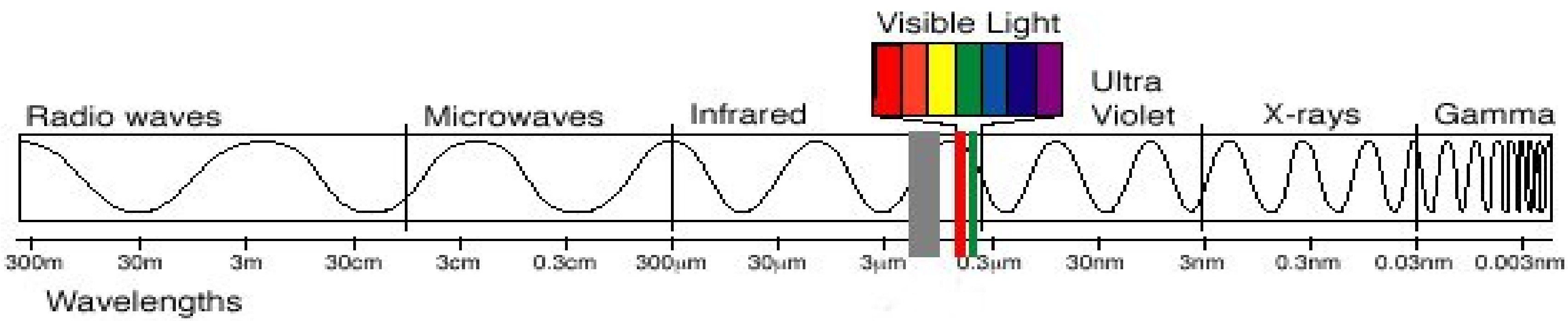
Radiation needs no medium to transfer energy. How powerfully something radiates will depend on its temperature.

Solar radiation bathes our planet with sunlight.

Radiation is a form of electromagnetic energy.

What are the common forms of electromagnetic energy?

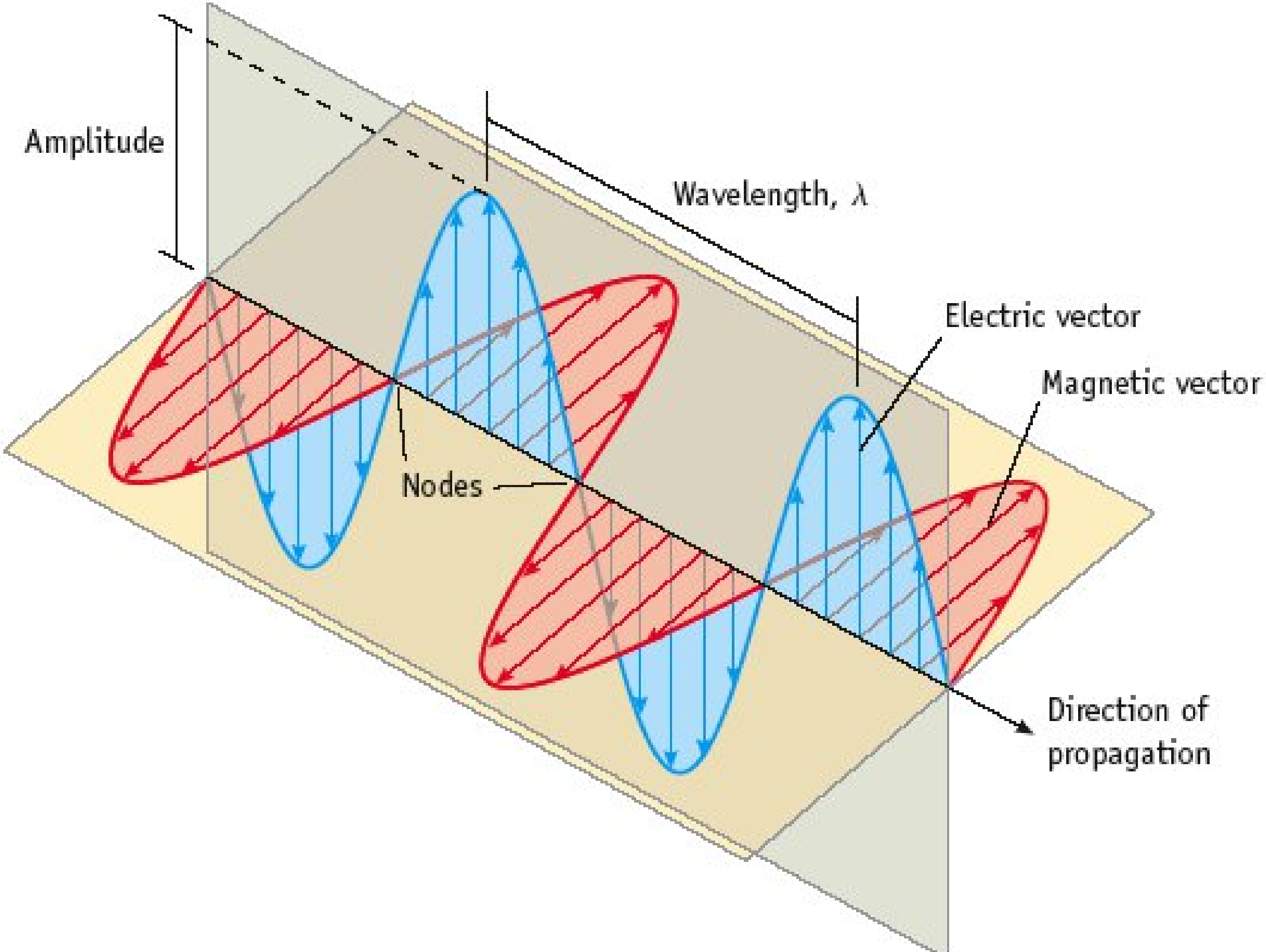
Visible light is just one form. Some other forms are, radio waves, heat, ultraviolet rays, and X-rays.



The Electromagnetic Spectrum

- Remote sensing uses the radiant energy that is reflected and emitted from the Earth at various wavelengths of the electromagnetic spectrum.
- Our eyes are sensitive only to the visible wavelengths of the EM spectrum. Special sensors help us to capture the rest, and to translate it into a form we can see and understand.

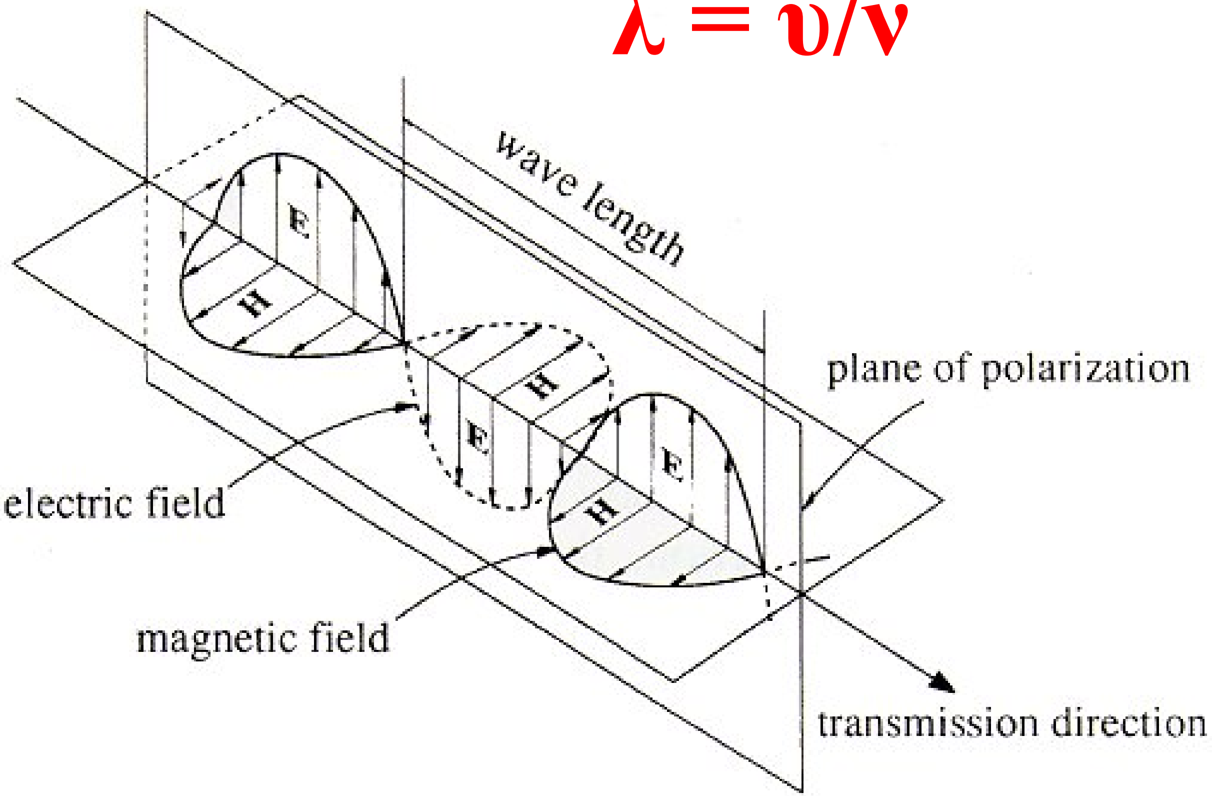
Electromagnetic Radiation



Electromagnetic radiation

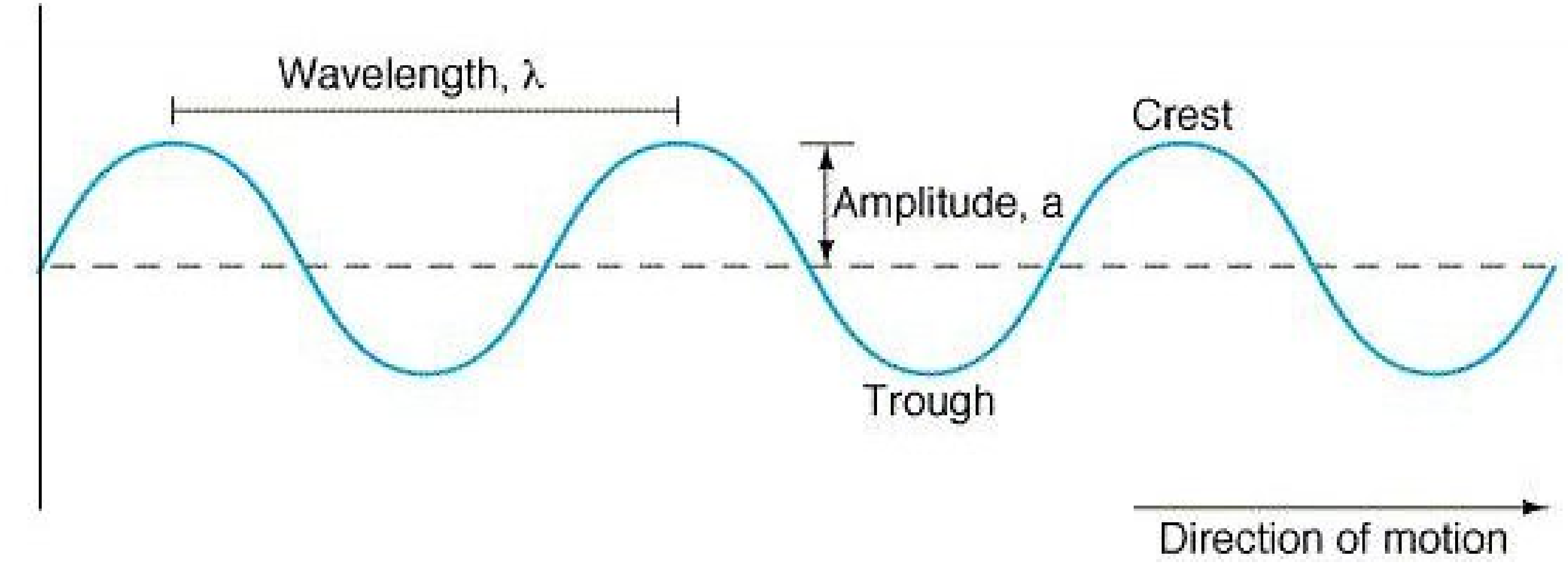
wavelength λ , frequency ν and the velocity υ have the following relation.

$$\lambda = \upsilon/\nu$$



Note: Electro-magnetic radiation has the characteristics of both wave motion and particle motion.

The three properties of electromagnetic energy



Wavelength (λ) is the distance from one wave crest to the next.

Amplitude is equivalent to the height of each peak, often measured as energy levels.

Frequency (ν) is measured as the number of crests passing a fixed point in a given period.

- **Distance from one wave peak to next is the wavelength (λ).**
- **Number of peaks passing a fixed point in space per unit time is the wave frequency (υ).**
- **Use the Greek letter “nu”, ●, for frequency, and units are “cycles per sec”**

- Equation for electromagnetic waves:

c = ✦ · ●

c = velocity of light = 3×10^8 m/sec

- Long wavelength --> small frequency
- Short wavelength --> high frequency

Particle theory

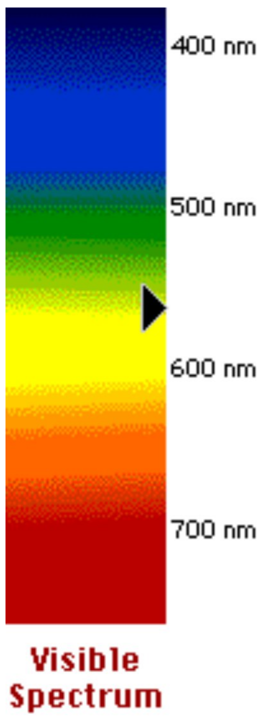
Better describes EMR interactions with matter. Electromagnetic energy consists of many discrete units called as **Photons** or **Quanta.**

$$Q = h\nu$$

Q = Energy of a Quantum, joules (J)
h = Planck's constant, 6.626×10^{-34} J sec
υ = Frequency

Relation between wave theory and Particle theory

$$Q = hc / \lambda$$



Short wavelength -->
high frequency
high energy

Long wavelength -->
small frequency
low energy

Stefan – Boltzmann Law

All matter above absolute zero (0◦K or -273◦C) continuously emit EMR. How much energy an object emits depends on the surface temperature of the object.

$$M = \sigma T^4$$

M= *total radiant exitance from the surface of the material, watts (W)* m^{-2}

σ = *Stefan – Boltzmann constant, 5.6697 x* 10^{-8} Wm^{-2} K^{-4}

T = *Absolute temperature (K) of the emitting material*

The above law is applicable for an energy source that behaves as a blackbody.

Blackbody is a hypothetical ideal radiator that totally absorbs and reemits all energy incident upon it.

Black body is a matter which absorbs all electro-magnetic energy incident upon it and does not reflect nor transmit any energy. It looks black at usual temperature.

A black body shows the maximum radiation as compared with other matter. Thus, a black body is called a perfect radiator.

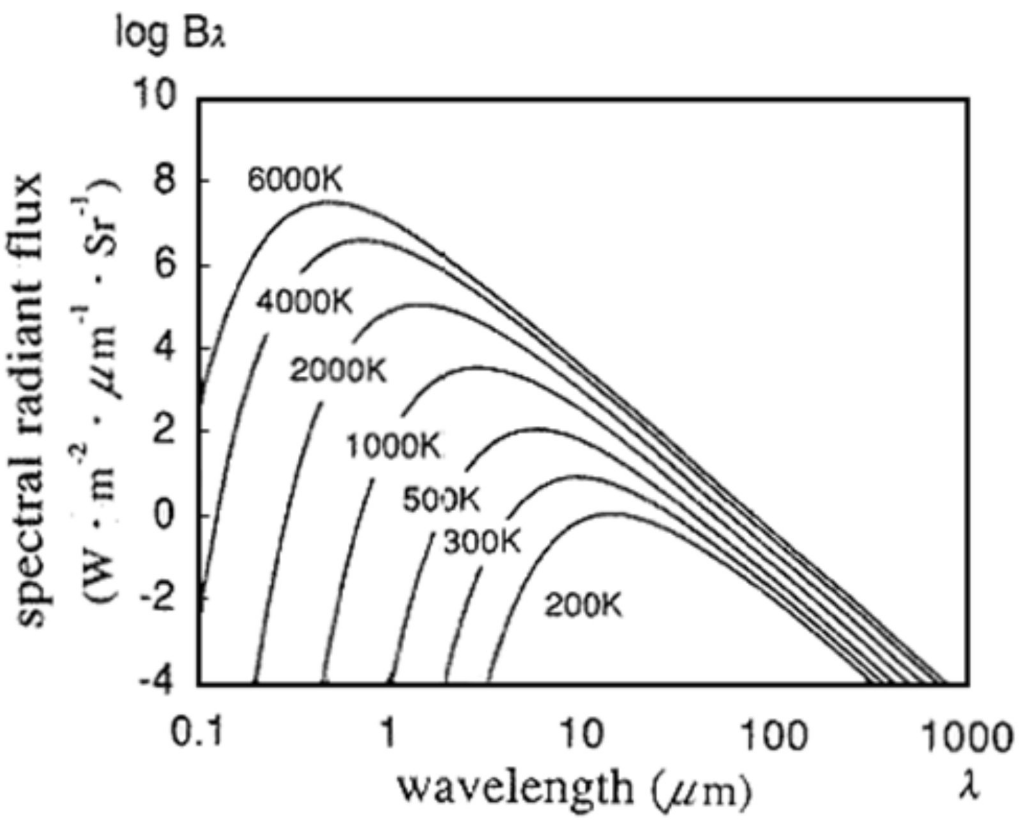
Just as the total energy emitted by an object varies with temperature, the spectral distribution of the emitted energy also varies.

The dominant wavelength, or wavelength at which a blackbody radiation curve reaches a maximum, is related to its temperature by Wien's displacement law.

$$\lambda m = A / T,$$

λm = wavelength of maximum spectral radiant exitance, µm
A = 2898 µm K
T = temperature, K

Black Body Radiation



Black body radiation

given by Plank's law as a function of temperature T and wavelength.