# BPT-201 (semester II)
# Topic: Blackbody Radiation-part 1 (Basics)

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# Thermal and Non-Thermal radiation

- Radiation includes electromagnetic waves and particles that are emitted by some materials and carry energy.
- It can take place in vacuum also and does not show its effect until and unless it false on some surface.
- All matters are composed of particles having kinetic energy due to temperature of matter. The matter consists of charged particles, i.e., protons and electrons. The kinetic interactions among matter particles result in charge-acceleration and dipole-oscillation, which results in generation of electromagnetic waves radiating out of matter body.
- This is called 'Thermal Radiation' which is the topic of present discussion.

- Does heating the material to get the radiation is the only way to get it?.....No. There are many other methods also and they are known as "Non-thermal Radiation'

- Lets have a look what are the Non-thermal Radiation sources
  i) A current carrying conductor having high frequency current
  ii) Electric discharge in a gas
  iii) A metal target irradiated by high speed electron
  iv) Emission from a radio active atom.
  v) A substance exposed to radiation may emit the radiation
  etc.

# Some important definitions

- There are some simple definitions to understand and quantify it
- If the radiation passes through some matter, then three fractional quantities are associated with it
  - ❖ part of radiation which is absorbed by the surface =a
  - ❖part of radiation which is transmitted by the surface=t
  - ❖part of radiation which is reflected by the surface=r
- Since all quantities are fractional quantities so $a + r + t = 1$
- Since the values of a, r and t depends upon the wavelength of radiation falling on the surface hence they are denoted as $a_\lambda$, $r_\lambda$ and $t_\lambda$

# .....Some important definitions

- When a=0 and t=0 that means no absorption and no transmission or we can say a body having r=1 is defined as PERFECT WHITE BODY as it reflects all radiation, on falling on its surface.
- When r=0 and t=0 that means no reflection and no transmission or we can say a body having a=1 is defined as PERFECT BLACK BODY as it absorbs all radiation, on falling on its surface.
- When a black body is heated it emits all radiation, which is called 'total radiation'

# .....Some important definitions

- Total Energy density: $u$ of any radiation at any point is given as amount of total radiant energy per unit volume around that point for all wavelength taken together. Its unit is joule/meter$^3$ or erg/cm$^3$ in SSI and CGS respectively.
- Spectral Energy density: $u_\lambda$ of any radiation at any point is given as amount of the radiant energy per unit volume per unit range of wavelength .

# .....Some important definitions

- Spectral Emissive power: $e_\lambda$ for wavelength range $\lambda$ and $\lambda+d\lambda$ is the energy of thermal radiation, at any given temperature (T), isotropically emitted by a body per unit time from each unit area of a surface.
- Total Emissive Power: E is the energy of thermal radiation, at any given temperature (T), isotropically emitted by a body per unit time from each unit area of a surface for all wavelengths taken together.
- Absorptive power: $a_\lambda$ of an isotropic body (or a surface) is defined as the ratio of the energy absorbed to the radiant energy incident on it when a radiation between $\lambda$ and $\lambda+d\lambda$ is incident on it from vacuum.
- The absorptive power of a perfect black body is 1 because it absorbs radiant energy of all wavelength incidents on it.

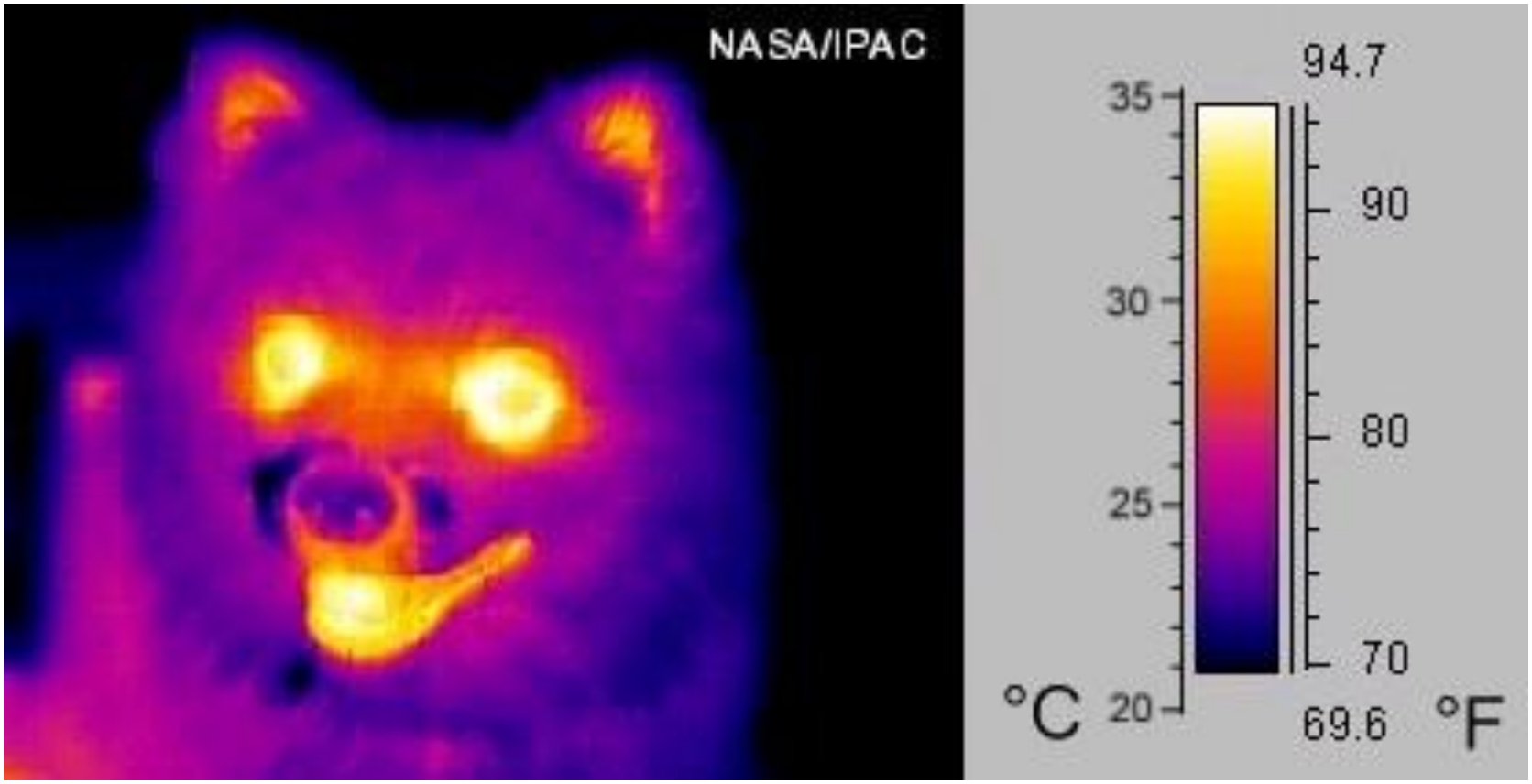
# Prevost's Theory Of Heat Exchange

- Prior to 1792, people considered that radiation from cold body and radiation from hot bodies are two different phenomenon
- In 1792 Prevost came with the present concept which says every material body, at any temperature above absolute zero, radiates heat to the surroundings and at the same time absorbs heat from the surroundings.
- A body will stop emitting radiation only when it is at absolute zero. At this temperature the kinetic energy of the molecule is zero.
- Therefore Prevost theory states that all bodies emit thermal radiation at all temperatures above absolute zero irrespective of the nature of the surroundings, except 0 K or -273° C.

# .....Prevost's Theory Of Heat Exchange

- The rate of emission of heat by a body does not depend upon the temperature of its surroundings.
- A body, at a higher temperature than the surroundings radiates heat at a faster rate than it absorbs. Hence it loses heat and its temperature falls.
- A body that is at a lower temperature than the surroundings absorbs heat at a faster rate than it radiates. Hence it gains heat, its temperature rises.
- Even in the case of thermal equilibrium, the process of radiation and absorption continues to take place. When there is no net loss or gain of heat i.e. when absorption rate is equal to rejection rate , Its temperature is unchanged.

Since thermal radiation is electromagnetic radiation like light and hence has been used for photographic purpose also because our body also radiates due to its temperature and the radiation generally lies in infrared region.




- Figure taken from:
  http://upload.wikimedia.org/wikipedia/commons/0/0c/Infrared_dog.jpg

- https://www.youtube.com/watch?v=aLwJKZ1Gf3g&list=PL42D75EB85932E7D3&index=1
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