Stephan-Boltzmann Law

- The amount of electromagnetic radiation emitted by a body is directly related to its temperature.
- If the body is a perfect emitter (black body), the amount of radiation given off is proportional to the 4th power of its temperature as measured in degrees Kelvin.
- This natural phenomenon is described by the Stephan-Boltzmann law:

$$E = \sigma T^4$$

Where $\sigma = 5.67 \times 10^{-8} Wm^{-2}k^{-4}$ and T is in K

Wien's Law

- The wavelength of maximum emission of any body is inversely proportional to its absolute temperature.
- Thus, the higher the temperature, the shorter the wavelength of maximum emission.
- This phenomenon is often called Wien's law:

$$\lambda_{\max} = \frac{C}{T}$$
$$C = 2897$$

where T is in Kelvin.

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Inverse Square Law

- The amount of radiation passing through a specific area is inversely proportional to the square of the distance of that area from the energy source.
- This phenomenon is called the inverse square law.
- Using this law we can model the effect that distance traveled has on the intensity of emitted radiation from a body like the sun.

$$Intensity = \frac{I}{d^2}$$

Where I is the intensity of radiation at one d and d is the distance traveled

Inverse Square Law

- Planets with no atmosphere all the Sun's radiation will strike the surface.
- Some of this will be reflected away from the planet but the rest will be absorbed.
- The temperature of the surface will be raised until there is equilibrium between the energy radiated by the warm surface of the planet and the received solar radiation.
- For planets like Mercury, this results in a very hot surface where the Sun is shining (more than 400°C) but very cold on the night side, where the radiation from the surface rapidly cools it to -180°C.

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Irradiance & Irradiation

- **Irradiance** is given in W/m^2 and is represented by the symbol G. The rate at which radiant energy is incident on a surface per unit area of surface.
- **Irradiation** is given in J/m^2 and is the incident energy per unit area on a surface - determined by integration of irradiance over a specified time, usually an hour or a day.
- **Radiosity** is the rate at which radiant energy leaves a surface, per unit area, by combined emission, reflection and transmission.

Solar Constant

- The solar constant I_{sc} is defined as the total energy received from the sun, per unit time, on a surface of unit area kept perpendicular to the radiation, in space just outside the earth's atmosphere when the earth is at its mean distance from the sun.

- Recent measurement of the solar constant have shown that it has a value of approximately 1353 W/m^2.

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Solar Constant

- Solar radiation intensity leaving the surface of the sun is given as:

$H_s = \sigma T_0^4$ (Assuming sun as a black-body)
σ is Stefan-Boltzman constant = $5.67 \times 10^{-8}\ W/m^2\text{-}K^4$
$T_0 = 5762°K$ (Average temperature on surface)

$$H_s = 5.961 \times 10^7\ W/m^2$$

Total radiant power, $P_0 = H_s \times 4\pi R^2$

$$R = Radius\ of\ the\ sun\ surface\ = 6.960 \times 10^8 m$$

$$P_0 = 3.630 \times 10^{26}\ W$$

At a distance of r, the radiant flux is:

$$H_0 = \frac{P_0}{4\pi r^2} = \frac{3.044 \times 10^{25}}{r^2} W/m^2$$

At mean earth-sun distance of $r = 1.5 \times 10^{11} m$; *radiation intensity is*: $1353\ W/m^2$

Instrumentation for measuring solar radiation

- **Pyrheliometer**:
  - ✓ Is an instrument for measuring the intensity of direct solar radiation at normal incident, it can either be a primary standard instrument or a secondary instrument scaled by reference to a primary instrument.
  - ✓ The latter have sometimes been called **actinometers**.
  - ✓ Is a small telescope like device mounted on a drive mechanism that causes it to follow the sun through the day.
- **Pyranometer**:
  - ✓ Is an instrument for the measurement of the solar radiation received from the whole hemisphere.
  - ✓ It is suitable for the measurement of the global or sky radiation usually on a horizontal surface.
  - ✓ Sometimes it called as solarimeter
  - ✓ If shaded from the beam radiation by a shade ring, it measures diffuse radiation.
  - ✓ Is usually mounted so that the hemisphere is the sky dome.

**Advantages and Disadvantages of the* Pyrheliometer & Pyranometer*?*

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Instrumentation for measuring solar radiation

- **Pyrgeometer**:
- ✓ Is an instrument for the measurement of terrestrial radiation only.
- **Pyradiometer**:
- ✓ Is an instrument for the measurement of both solar and terrestrial radiation that is for net atmospheric radiation on a horizontal upward facing black surface at the ambient air temperature.

Instrumentation for measuring solar radiation

- **Pyrheliometer**:
- ✓ Three pyrheliometer have been in wide-spread use to measure normal incident beam radiation:
  1) Angstrom compensations
  2) Abbot silver disc
  3) Eppley

Direct & Diffused radiation

- Sunlight reaching the Earth's surface unmodified by any of the atmospheric processes is termed direct solar radiation.
- Solar radiation that reaches the Earth's surface after it was altered by the process of scattering is called diffused solar radiation.
- Not all of the direct and diffused radiation is available at the Earth's surface. Some of the radiation received at the Earth's surface is redirected back to space by reflection.

**Latitude and the hour angle?*

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