ASTR100: INTRODUCTION TO ATRONOMY

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Stefan-Boltzmann law for thermal radiation at temperature T (in Kelvin):

$$E = \sigma T^4$$

$Where,$

$E = \ Emitted\ Power\ (per\ sqaure\ meter\ of\ surface)$

$T = temperature\ in\ Kelvin\ and$

$$\sigma = Stefan - Boltzmann\ Constant = \ 5.7\ \times\ 10^{-8} \frac{watt}{m^2 \times\ K^4}$$

Stefan-Boltzmann law that shows the relation between luminosity, temperature and radius:

$$L = 4\pi r^2\ \sigma T^4$$

Where,

L = Luminosity

$4\pi r^2$ = Star's surface area ('r' is the radius of the star)

$\sigma = Stefan - Boltzmann\ Constant$

T = surface temperature of the star (in Kelvin)

Almost all stars are too distant for us to measure their radii. This relation is mostly used to calculate the radius of the star from its luminosity and surface temperature, that is,

$$r = \sqrt{\frac{L}{4\pi\sigma T^4}}$$

Wien's law for peak wavelength (λ_{max}) thermal radiation at temperature T (in Kelvin):

$$\lambda_{max} = \frac{b}{T} = \frac{2{,}900{,}000}{T}$$

$Where,$

$\lambda_{max} = wavelength\ of\ maximum\ intensity\ (nm)$

$b = Wien's\ constant = 2{,}900{,}000\ nm.K$

$T = temperature\ in\ Kelvin$

Doppler shift (radial velocity is positive if the object is moving away from us and negative if it is moving towards us):

$$\frac{v_{rad}}{c} = \frac{\lambda_{shift} - \lambda_{rest}}{\lambda_{rest}}$$

$Where,$

$v_{rad} = object''s\ radial\ velocity$

$\lambda_{shift} = rest\ wavelength\ of\ a\ particular\ spectral\ line\ (nm)$

$\lambda_{rest} = shifted\ wavelength\ of\ the\ same\ line\ (nm)$

$c = speed\ of\ light = 3 \times 10^5\ km/s$

Inverse square law for light:

$$b = \frac{L}{4\pi\, d^2}$$

Where,

b = Apparent brightness

L = Luminosity

d = distance to the object

Newton's version of Kepler's third law:

$$P^2 = \frac{4\pi^2}{G\ (M_1 + M_2)} . a^3$$

Where,

P = orbital period (in seconds)

a = orbital distance (in meters)

M_1 and M_2 = mass of first and second object respectively (in kg)

G = gravitational constant ($6.673 \times 10^{-11}\ m^3\ kg^{-1}\ s^{-2}$)

If the period, distance and masses are in years, AU and solar masses respectively, then,

$$P^2 = \frac{a^3}{M_1 + M_2}$$

Universal law of gravitation:

$$F_{grav} = \frac{G\ M_1 M_2}{d^2}$$

Where,

F_{grav} = Magnitude of the gravitational force between the two point masses

M_1 and M_2 = Mass of the first and second object respectively (in kg)

G = Gravitational Constant ($6.673 \times 10^{-11}\ m^3\ kg^{-1}\ s^{-2}$)

d = distance between the two point masses

Other important formulae:

$$Density = \frac{Mass}{Volume}\ or\ \rho = \frac{m}{V}$$

$$Volume\ of\ Sphere, V = \frac{4}{3}\pi r^3$$

Speed of light = wavelength × frequency

That is, $c = \lambda \times f$