Astronomy and Cosmology

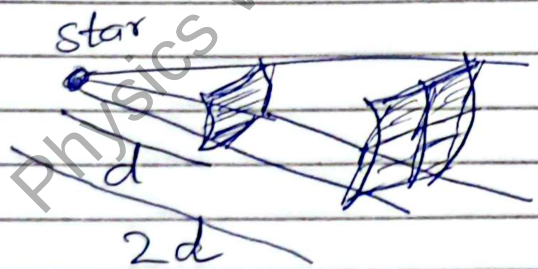
Luminosity

Total radiation power emitted by a star.

- It is represented by L
- Unit is watt (W)

Radiant flux intensity

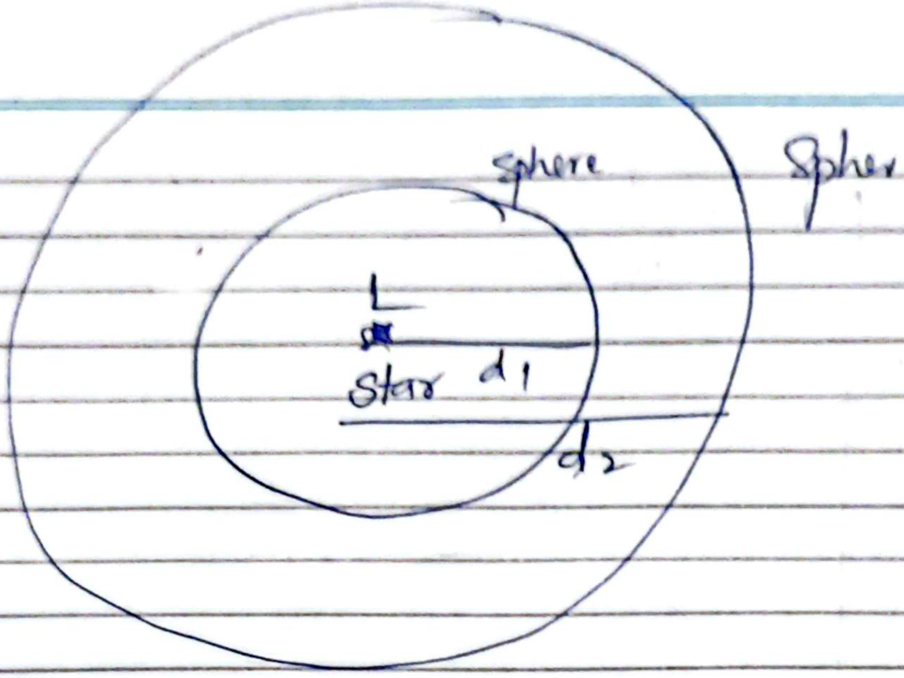
$$I = \frac{P}{A} = \frac{L}{A}$$



If distance is increased by factor 2 area ~~of~~ increases by factor of $\underline{4}$

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

dis radius



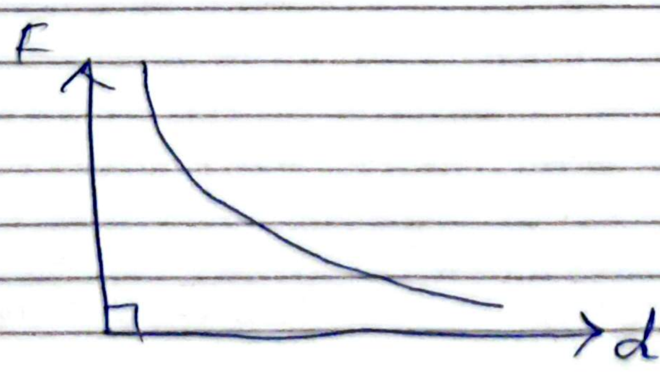
$4\pi d^2$ = Surface area of sphere.

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

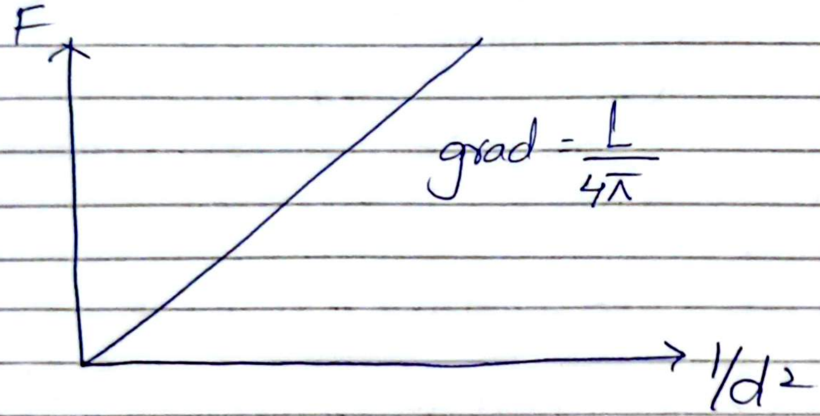
It is represented by F

$$\boxed{F = \frac{L}{4\pi d^2}}$$

F = radiant flux intensity



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



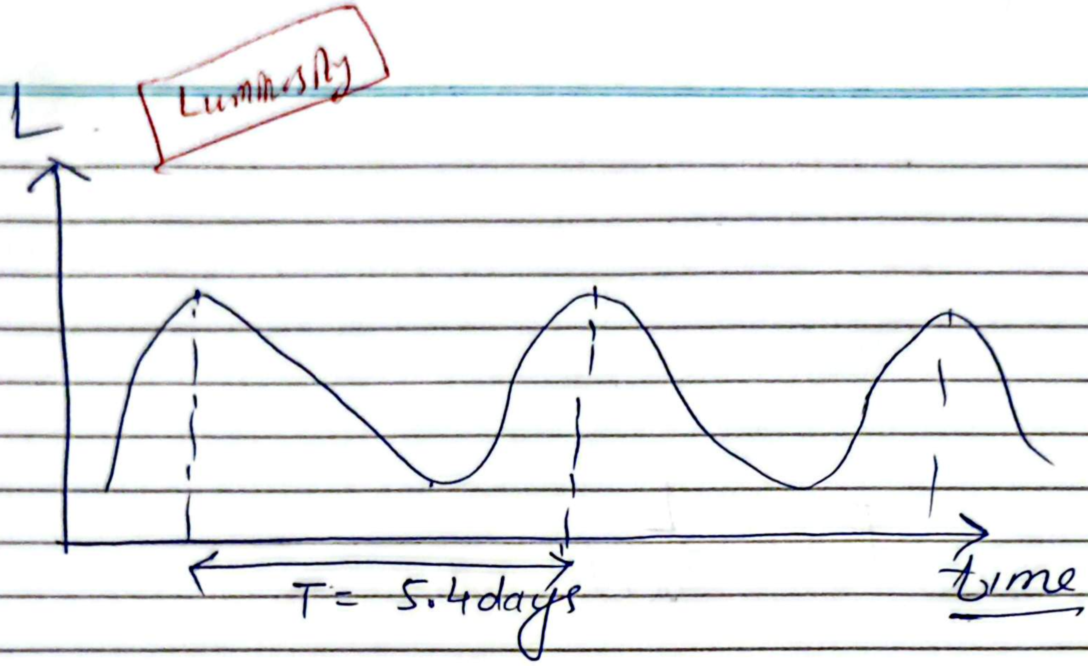
Standard Candle

"An object (star) of known Luminosity."

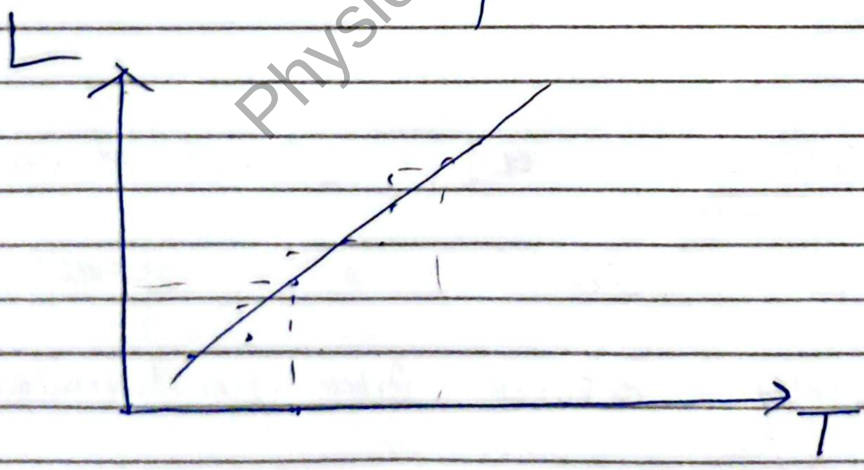
Example

① Cepheid veriable star

This is an example of star whose Luminosity changes (Increases and decreases) periodically.



All stars whose Luminosity changes periodically have relationship of Luminosity with time period



(2) Type Ia Supernova

Using Standard candle to find distance of star from earth

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

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

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

$$d = \sqrt{\frac{L}{4\pi F}}$$

L: known as the star standard candle

F: on earth is measured using device like photometer

Wien's displacement

Maximum Intensity wa
is inversely propo
to absolute (Therm
temp of the sta

$$\lambda_{max} \propto \frac{1}{T}$$

$T_3 > T_2 > T_1$ $\lambda_1 >$

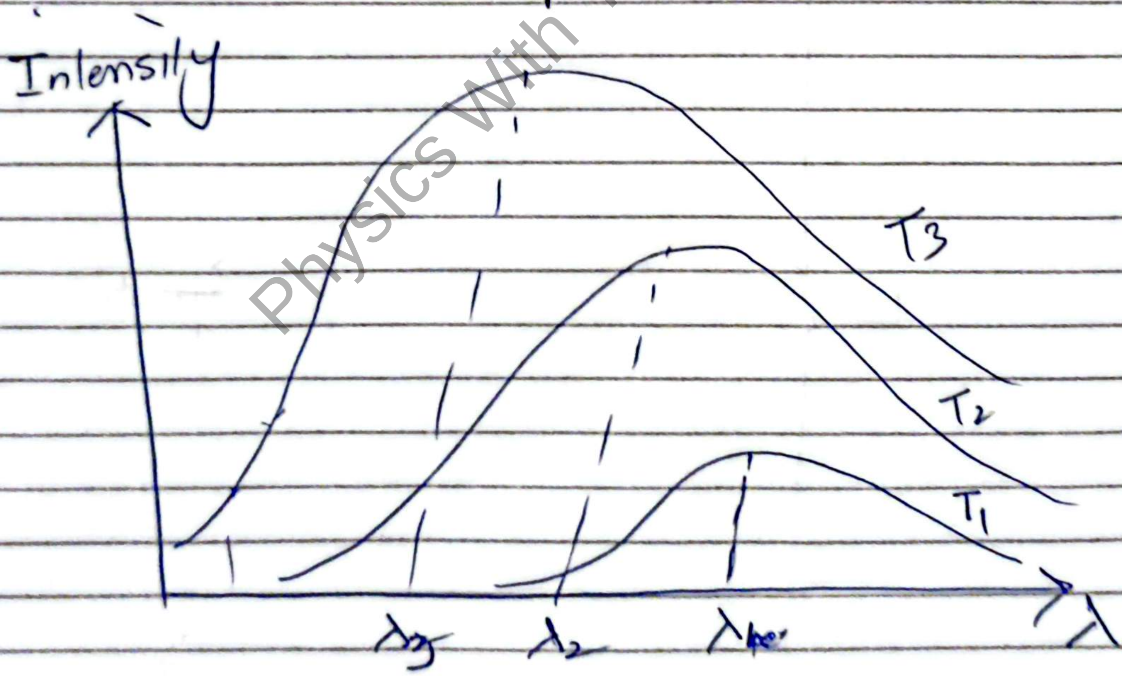
$$T_1\lambda_1 = T_2\lambda_2$$

Wien's displacement law

Maximum Intensity wave length is inversely proportional to absolute (Thermodynamic) temp of the star.

temp in kelvin

$$\lambda_{max} \propto \frac{1}{T} \qquad \lambda_{max} T = \text{Constant}$$



$T_3 > T_2 > T_1 \qquad \lambda_1 > \lambda_2 > \lambda_3$

$T_1 \lambda_1 = T_2 \lambda_2$

Stefan-Boltzman Law

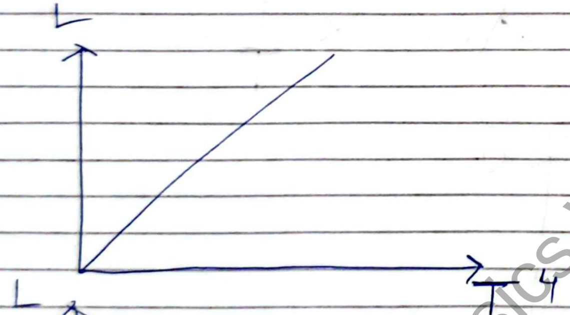
$L \propto T^4$

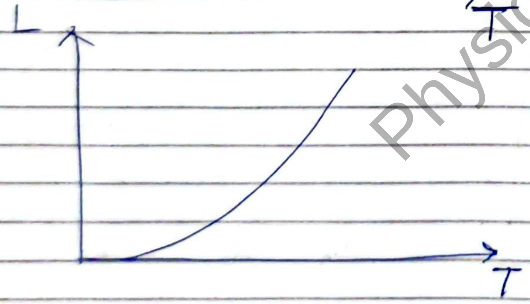
"Luminosity of a star is directly proportional to fourth power of thermodynamic temperature"

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

R: radius of star

σ: Stefan-Boltzman constant





$$\boxed{L = 4\pi \sigma R^2 T^4}$$

How to find Radius of a star using Stefan Boltzman Law and Wie displacement Law?

Using wien's disp la find temperature of th star by observing its light wave length (λ then use Stefan Bolt Law to find radi

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

L → standard candle

T → from wien's c

R → calculate R

How to find Radius of a star using Stefan Boltzman Law and Wein's displacement Law?

Using wien's disp law find temperature of the star by observing its light wave length. ($\lambda_{max} \propto \frac{1}{\lambda}$)

Then use Stefan Boltzman Law to find radius

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

$L \downarrow$ standard candle

$T \downarrow$ from wien's displacement law

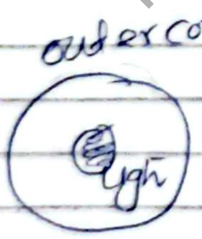
$R \downarrow$ calculate R

Doppler's effect

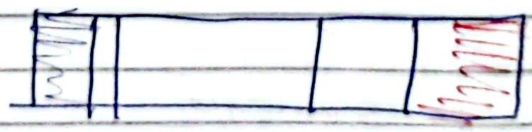
Change in wave length (frequency) of wave due to relative motion of source and observer.

Red Shift

Increase in wave length due to motion of a galaxy away from earth.

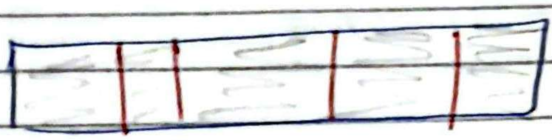


Star

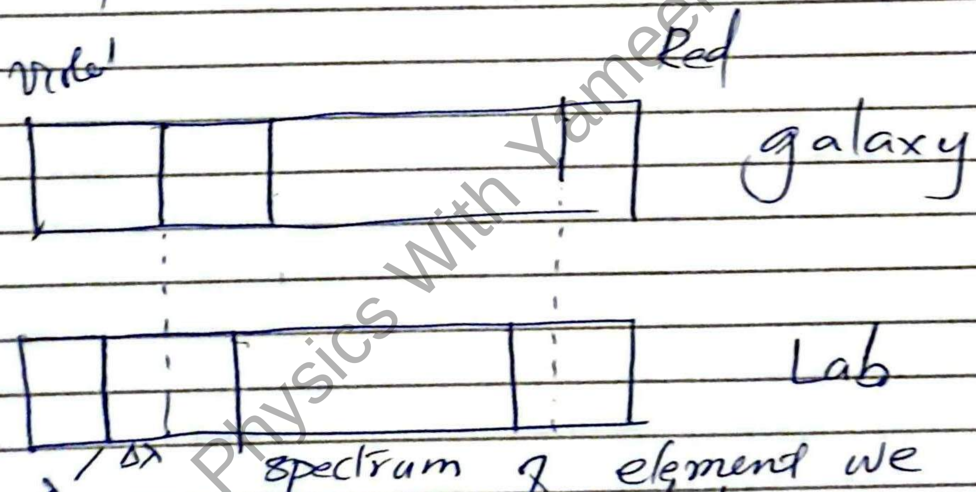


Black lines on coloured background

There are black lines or colured lines in spectrum of a star



We observe Spectrum from a star using spectrometer then we compare this spectrum with spectrum in lab



spectrum of element we know in lab

each line of spectrum of galaxy is shifted toward red side.

Formula

$$\frac{\Delta\lambda}{\lambda} \approx \frac{\Delta f}{f} = \frac{v}{c}$$

v → relative speed of galaxy

c → speed of light

$$\frac{\Delta\lambda}{\lambda} \approx \frac{\Delta f}{f} \approx \frac{v}{c}$$

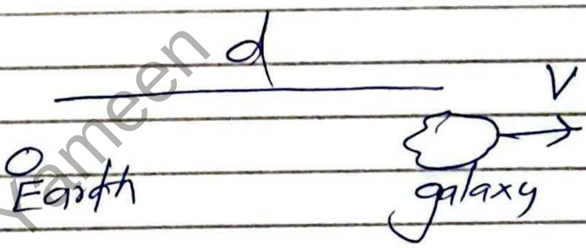
λ: original wave length of any line

$\Delta\lambda$: $\lambda_{galaxy} - \lambda_{lab}$

Hubble's Law

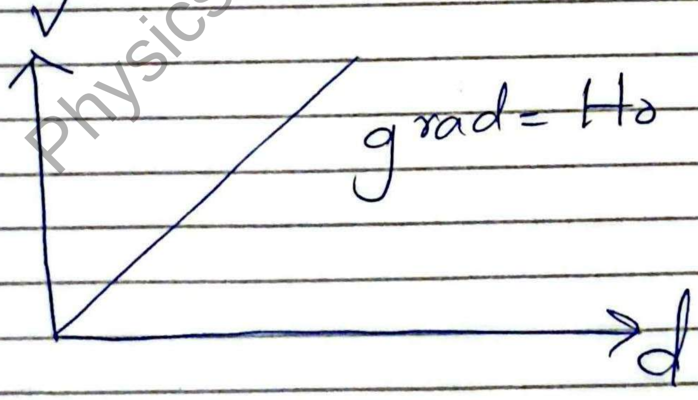
Recession speed of a galaxy is directly proportional to its distance from earth.

$v \propto d$



$$\boxed{V = H_0 d}$$

H_0: Hubble constant



H_0 :

Red shift and Hubble law show ~~earth~~ ~~is~~ universe is expanding. It must have started from explosion known as big bang theory

$$\text{age of univers} = \frac{1}{H_0}$$