# Hubble's Law:How old is the Universe?

Rakesh Nath

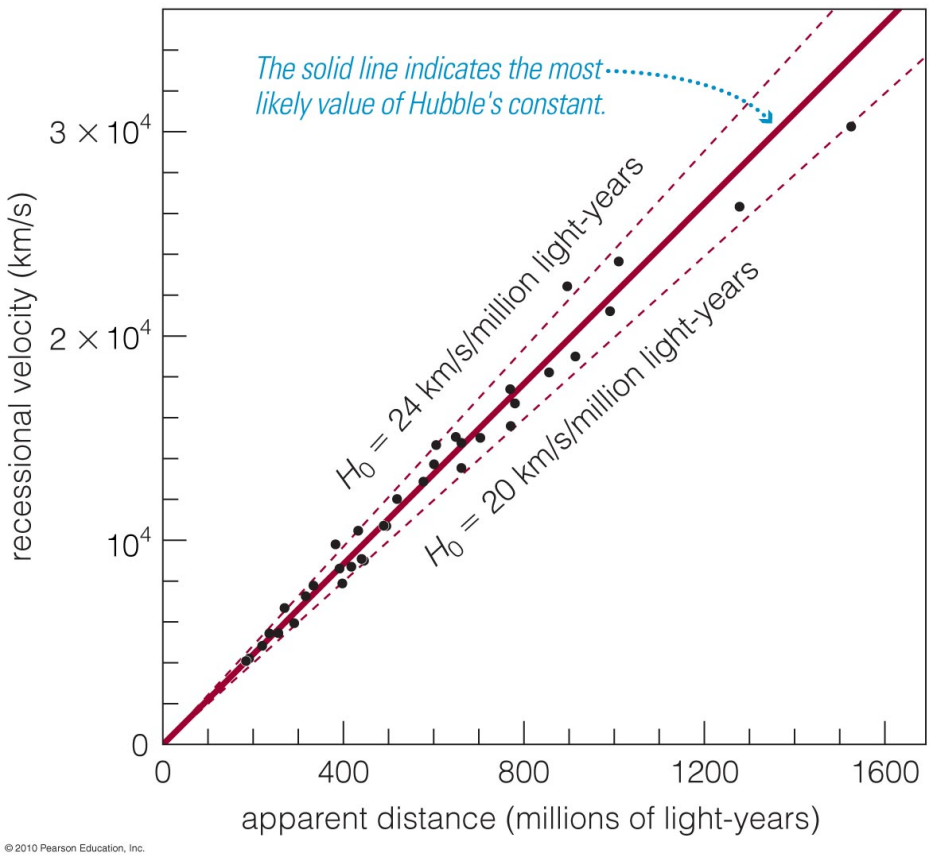
April 18, 2013

# What is the Hubble's constant?

- What exactly do astronomer's use Hubble's constant for?

# What is the Hubble's constant?

- What exactly do astronomer's use Hubble's constant for?
- The Hubble's constant defines the expansion rate of the Universe by the formula $V = H_O \times d$ where $d$ is the distance from the object and $H_O$ is the Hubble's constant and $V$ is the velocity with which the object is receding from the observer AKA us!
- The Hubble's law at some level represents the change in the velocity with distance and the Hubble's constant as a slope of this relation.
- The Hubble's constant is important in various levels because if we know the Hubble's constant accurately we can measure an important property of the age of the Universe.



# Redshift

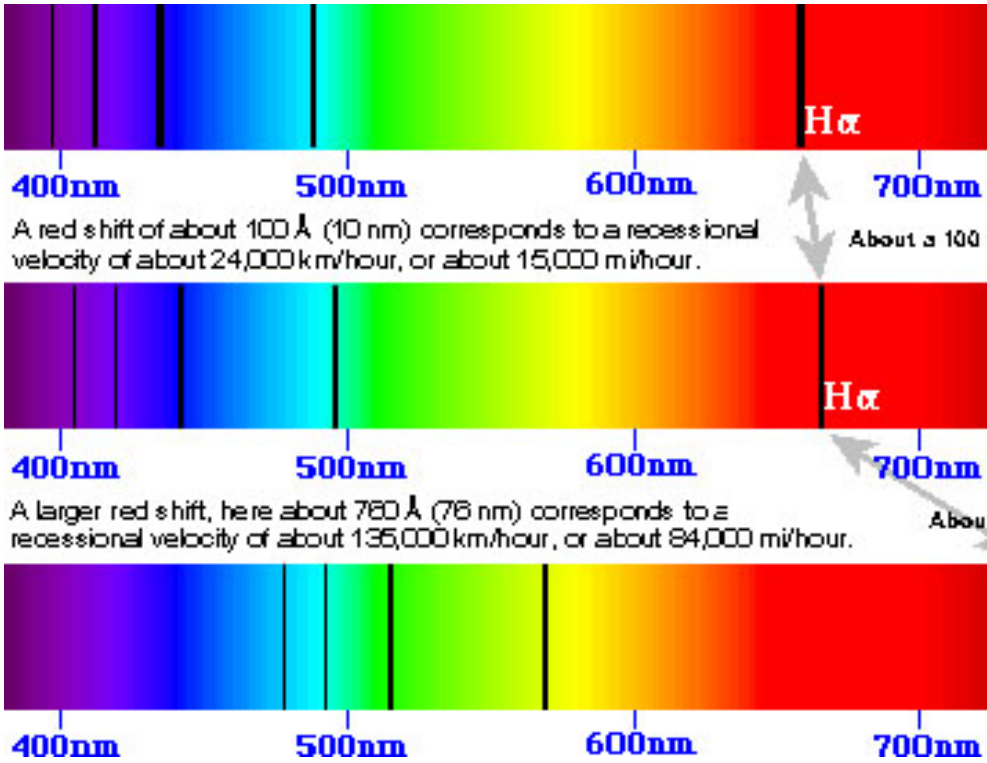
- Have you heard of redshift?

# Redshift

- Have you heard of redshift?
- Redshift is the apparent change in frequency when the observed source has relative motion with the destination. The redshift is measured using the formula

$$z = \frac{\Delta\lambda}{\lambda}$$

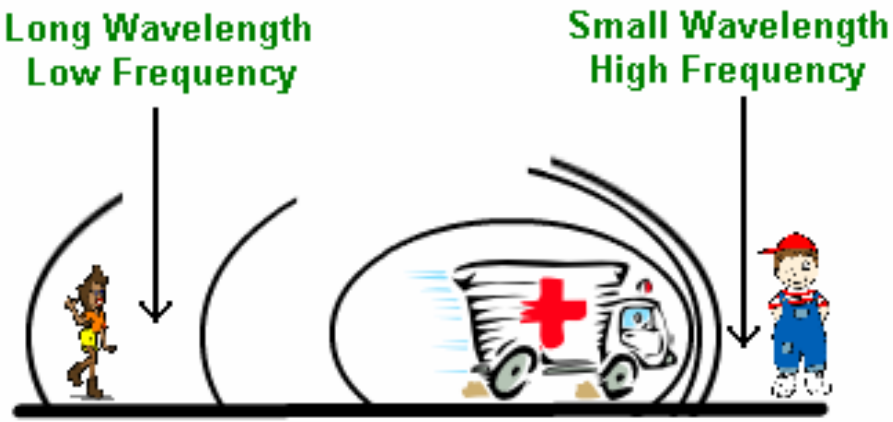
  where $\lambda$ is the wavelength without any redshift, $\Delta\lambda$ is the change in wavelength due to redshift
- The figure shows redshift of the H$\alpha$ wavelength we saw in the Sun lab




You will be measuring redshifts of various galaxies in this lab looking at the spectral shifts

# when do you have redshifts?

- When the source moves towards the observer the waves scrunch together as shown and result in a shorter wavelength and a higher frequency, this means the observed frequency/wavelength becomes lesser/shorter.
- When the source moves away from the observer, the wavelengths stretch out and becomes longer(reducing in frequency) making it "redder" and hence "redshifts".
- Therefore do galaxies(assuming the universe is expanding and no other motion) get redshifted or blueshifted?



The Doppler Effect for a Moving Sound Source

# How far can we see?

- You have a problem where you want to know if a supernova is visible in a particular galaxy.
- You will first assume that brightness of the supernova is $6 \times 10^6$ units(don't worry what units).
- Now 1 MPc corresponds to a brightness of $6 \times 10^6$. The inverse square law

$$\text{brightness} \propto \frac{1}{\text{distance}^2}$$

- So distance with brightness of $6 \times 10^6$ is 1 Mpc, now you have to find the distance at which the brightness reduces to 1 unit.

# How far can we see?

- You have a problem where you want to know if a supernova is visible in a particular galaxy.
- You will first assume that brightness of the supernova is $6 \times 10^6$ units(don't worry what units).
- Now 1 MPc corresponds to a brightness of $6 \times 10^6$. The inverse square law

$$\text{brightness} \propto \frac{1}{\text{distance}^2}$$

- So distance with brightness of $6 \times 10^6$ is 1 Mpc, now you have to find the distance at which the brightness reduces to 1 unit.
- Do the math! Call me if you are confused