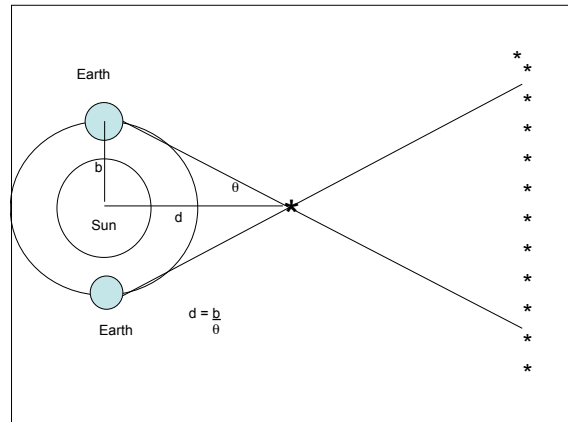


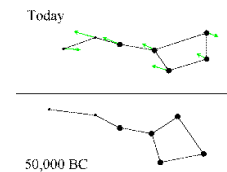
The Family of Stars

- One of the most important and difficult things to do in astronomy is to find the distances to the stars
- As you change your position objects that are closer to you seem to move more than objects that are farther away
- We can measure them by doing *parallax*



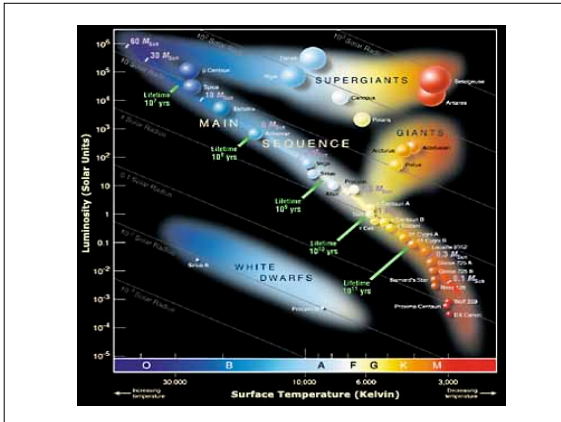
- As we move around the Sun nearby stars appear to move against the background stars
- We use a new unit of distance called the *parsec* which is the distance that a star would have a parallax of 1°
- This distance is 206,265 AU
- From the Earth we can only do parallax out to about 50 pc due to the atmosphere
- Satellites allow us to go out to about 200 pc now

- Many stars are just too far away to use parallax
- We must watch them for years and measure their motion across the sky
- This motion is called *proper motion* and is measured in sec/year



- One of the hardest things to do in astronomy is determine distance to an object or star
- If we use apparent brightness then all we know is that star A is brighter than star B
- But that doesn't take in to consideration their distances
- For this reason we have developed the *absolute magnitude scale*
- To do this we "place" all the stars at 10 pc
- That way all the stars are measured on an equal footing

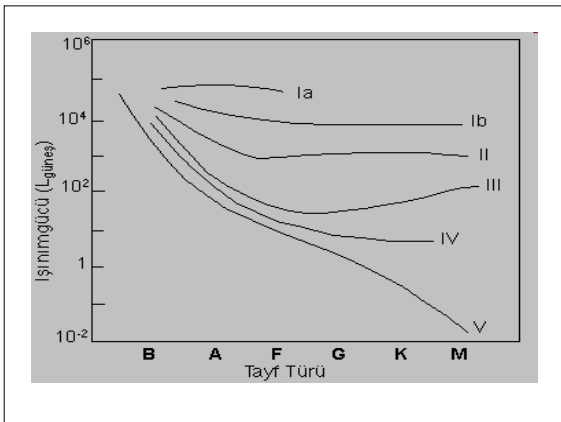
- Every 5 magnitudes difference is 100 times in brightness
- If the difference is 10 magnitudes it is 10,000 times in brightness
- When we look at a star's energy output we talk about its *luminosity*
- This refers to the stars total energy output
- One of the most important charts in astronomy is the *Hertzprung-Russell Diagram*
- It compares a stars brightness and the temperature



- A star will live 85% of its life on the *main sequence*
- Above and right you find the *giant stars*
- They are larger and cooler than the main sequence which is why they are red
- Above that are the *supergiants* which are extremely luminous
- They are 10 – 1000 times the size of the Sun
- At the bottom right you find the *red dwarfs* which are cool, small stars

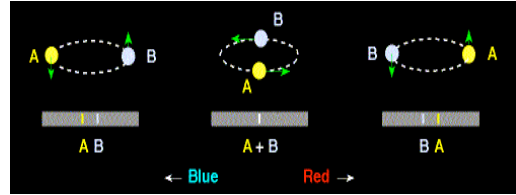
- In the lower left you find the *white dwarfs*
- They are extremely hot, small objects
- Each of these types of objects have very specific spectra
- That means that we can look at the spectrum of a star and determine the type of star it is
- This led to what we call the *luminosity classification*

- Ia Bright Supergiants
- Ib Supergiants
- II Bright Giants
- III Giants
- IV Subgiants
- V Main Sequence
- This allows us to classify all of the stars that are burning hydrogen fuel



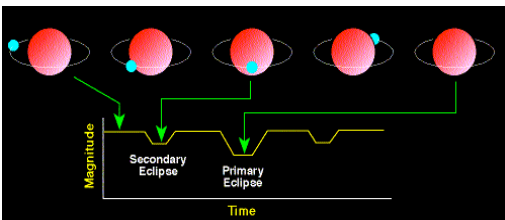
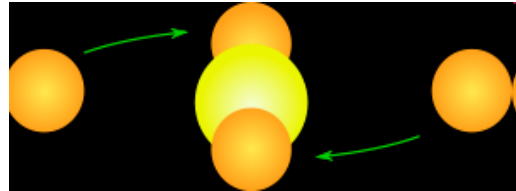
- Another difficult thing to do in astronomy is determine the masses of a single star
- It is much easier to measure the masses if they are in orbit with something else
- One such setup is a *binary star* system which is 2 stars in orbit around each other
- The masses can be calculated by using a variant of Kepler's third law
- $M_A + M_B = a^3/P^2$
- This allows you to determine the total mass of the system

- From there you can look at the 2 stars and determine each stars mass
- There are 3 basic kinds of binary stars
- *Visual binaries* are 2 stars that orbit each other and each star can be seen
- *Spectroscopic binaries* are stars that are so close that you can't see each of them
- The only way it can be done is to look at the spectrum of the system and you can see them separate out and come together



Spectroscopic Binary Star

- *Eclipsing binaries* are 2 stars that eclipse each other
- That means that they line up just right for us to see it
- We can watch the light curve to see the eclipse happening



- After all of this work over the years we have developed a formula to compare the mass and luminosity of main sequence stars
- $L = M^{3.5}$
- A 4 solar mass star will have about 128 times the brightness of the Sun
- A small difference in mass is a large difference in luminosity