Unit 2: The Sun and Other Stars

Objective:

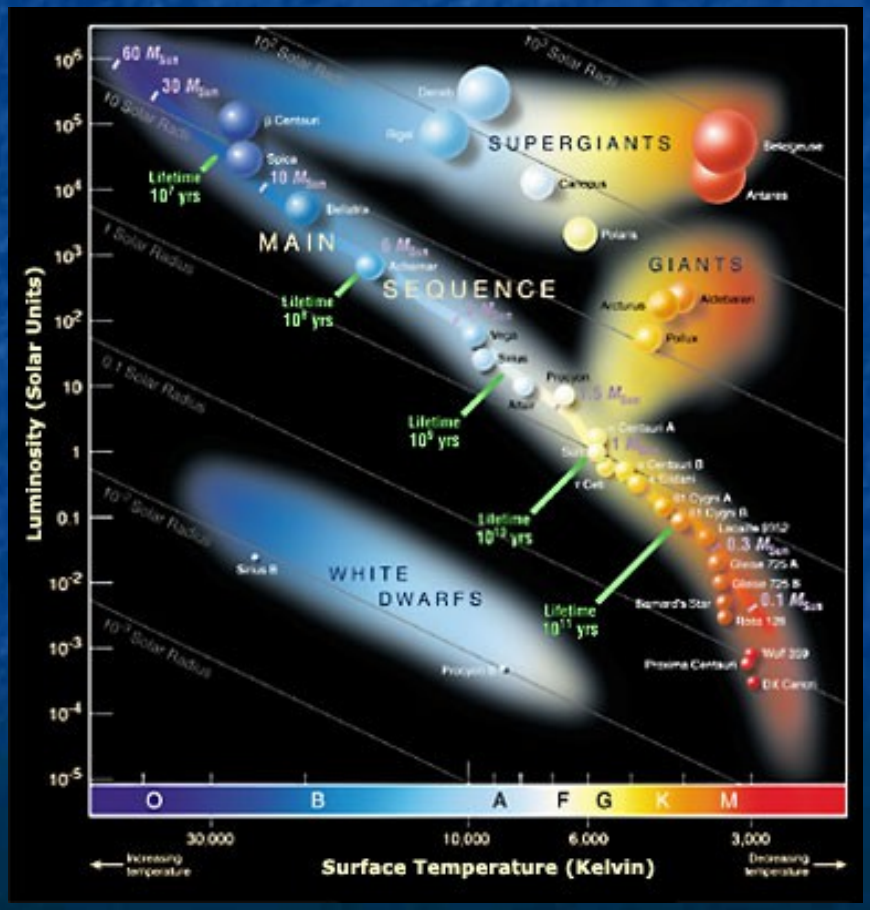
E5.2e - Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).

E5.2f - Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycle of stars.

The Hertzsprung-Russell Diagram*

The H-R diagram plots the luminosity (brightness) or absolute magnitude of stars against their surface temperatures.

Most stars fall into distinct groups in the H-R diagram, because the groups represent stages in the life cycles of the stars.



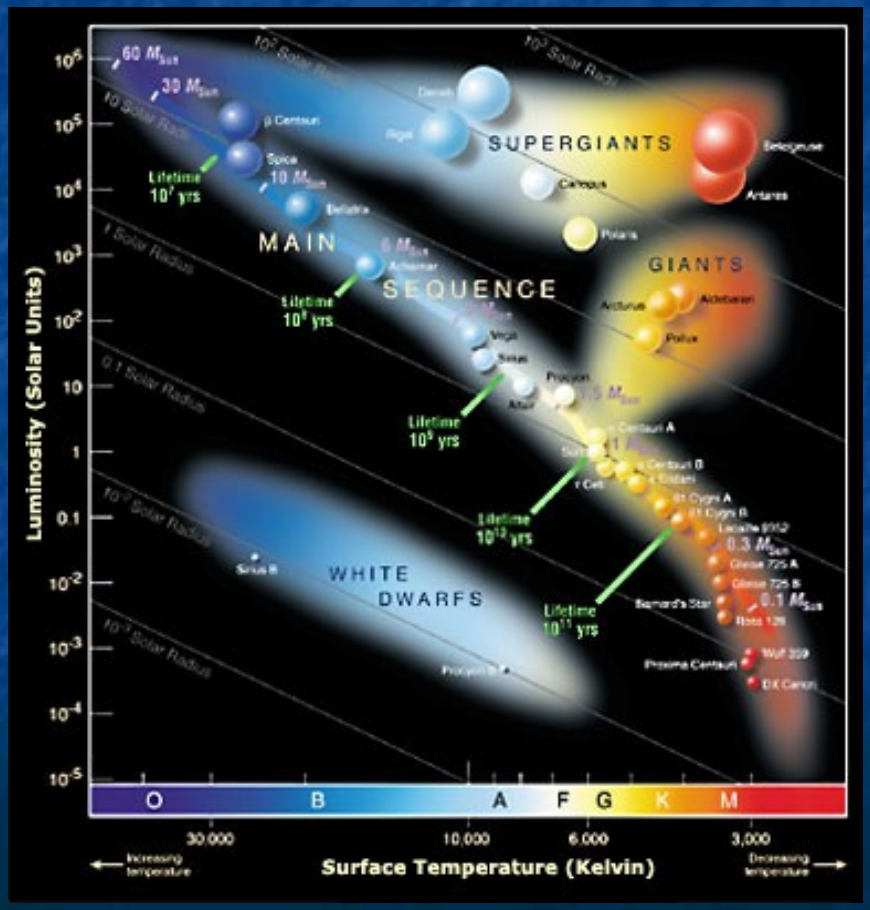
The Hertzsprung-Russell Diagram

The stars in the universe are at different stages in their life cycles.

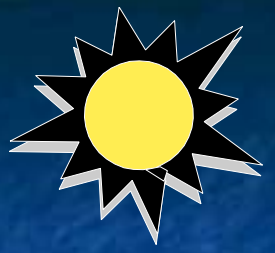
Some stars are young and hot; others are older and colder.

The Hertzsprung-Russell Diagram (or H-R Diagram) gives us a picture of a star's life.

Named for astronomers Ejnar Hertzsprung (of Denmark) and Henry Norris Russell (of the United States).



Apparent Magnitude

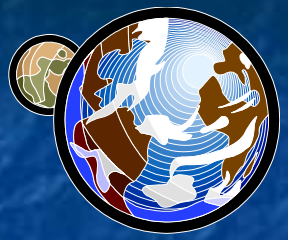


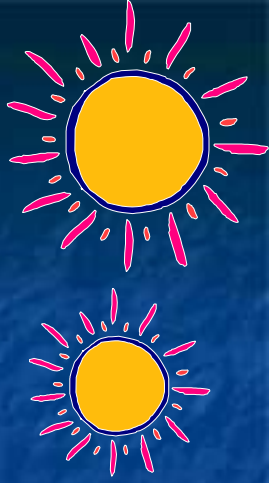
The apparent magnitude of a star is a measure of how bright a star appears to be to an observer on Earth.

The lower the apparent magnitude number, the brighter the star is. Some of the brightest stars in the sky are classified as first-magnitude stars. The faintest stars that can be seen with our unaided eye are called sixth-magnitude stars. Each magnitude differs from the next by a factor of about 2.5.

Some stars are so bright that they have a negative apparent magnitude.

Luminosity and Absolute Magnitude





Absolute magnitude is a measure of how bright a star would be if all stars were at the same distance (ten parsecs) from Earth.

Thus, distance from Earth no longer becomes a factor in how bright a star is. Remember, very bright stars that are very far from Earth may appear to be very faint to us.

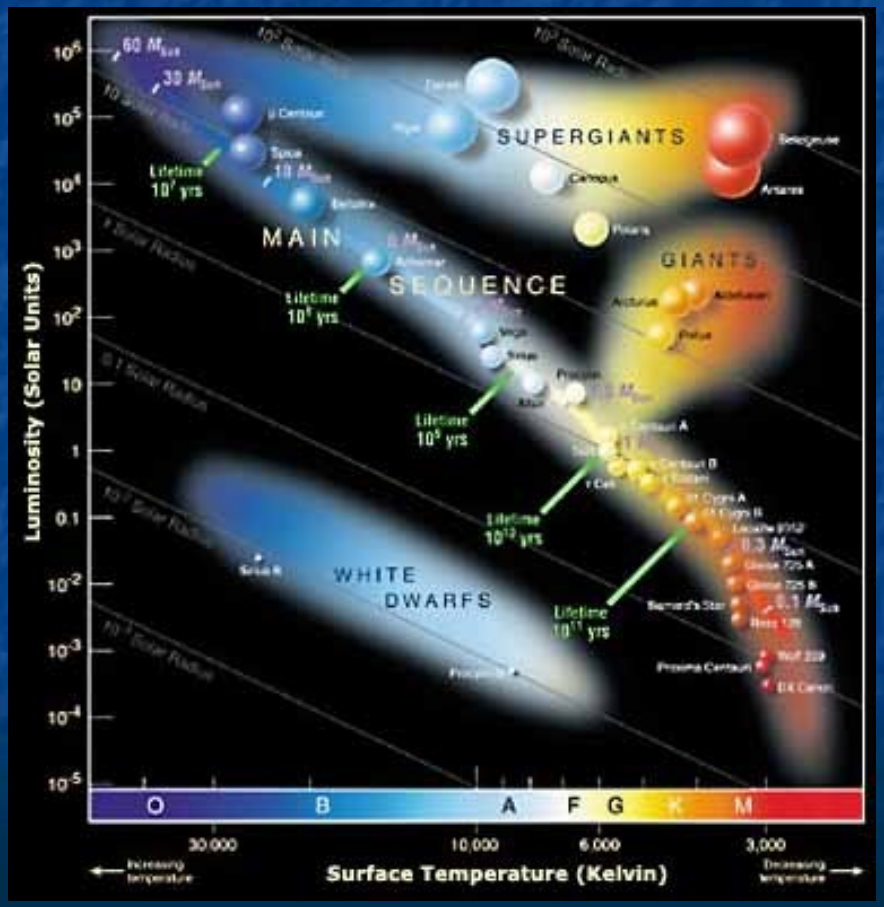
For example: Since our sun is so close to Earth, it has an apparent magnitude of –26.7. However, the sun has an absolute magnitude of only +4.8.

Remember, the mass and the temperature of the star are important!

Determining Distance*

Astronomers are able to calculate the distance a star is located from the Earth by taking the difference in a stars' apparent magnitude and absolute magnitude.

Distance can be then determined in parsecs. A parsec is equal to 3.258 light-years.



Mass, Size, and Temperature of Stars

Stars vary greatly in their masses, size, and densities.

We cannot observe a star's mass directly. We can only calculate it based on other observations. It can be determined either by the inertial properties of the body or by its gravitational influence on other bodies.

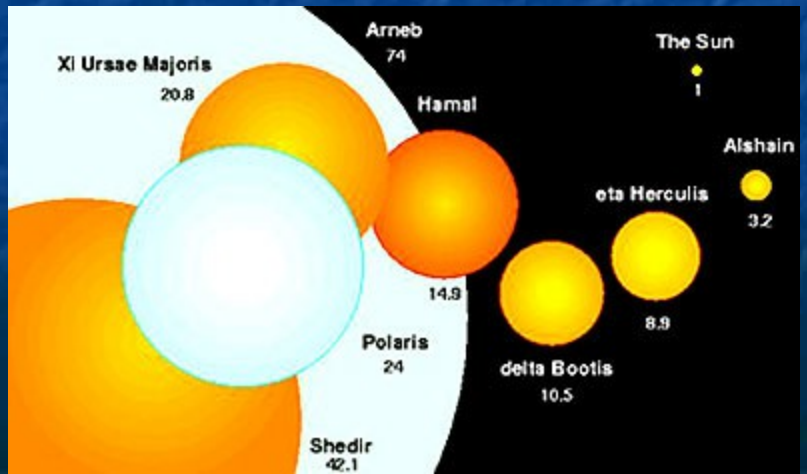
The larger the mass, the stronger the gravitational effect on the bodies around it.

Stellar masses are expressed as multiples of the mass of our sun, which is called one solar mass.

Mass, Size, and Temperature of Stars

Stars vary more in size than they do in mass. The smallest stars are smaller than Earth. The largest star known has a diameter more than 2000 times that of our sun.

Stars differ even more in density. Betelgeuse is about one ten-millionth as dense as our sun. However, one star near Sirius is so dense that one teaspoon of it would weigh more than a ton on Earth.



Temperature and Color of Stars*

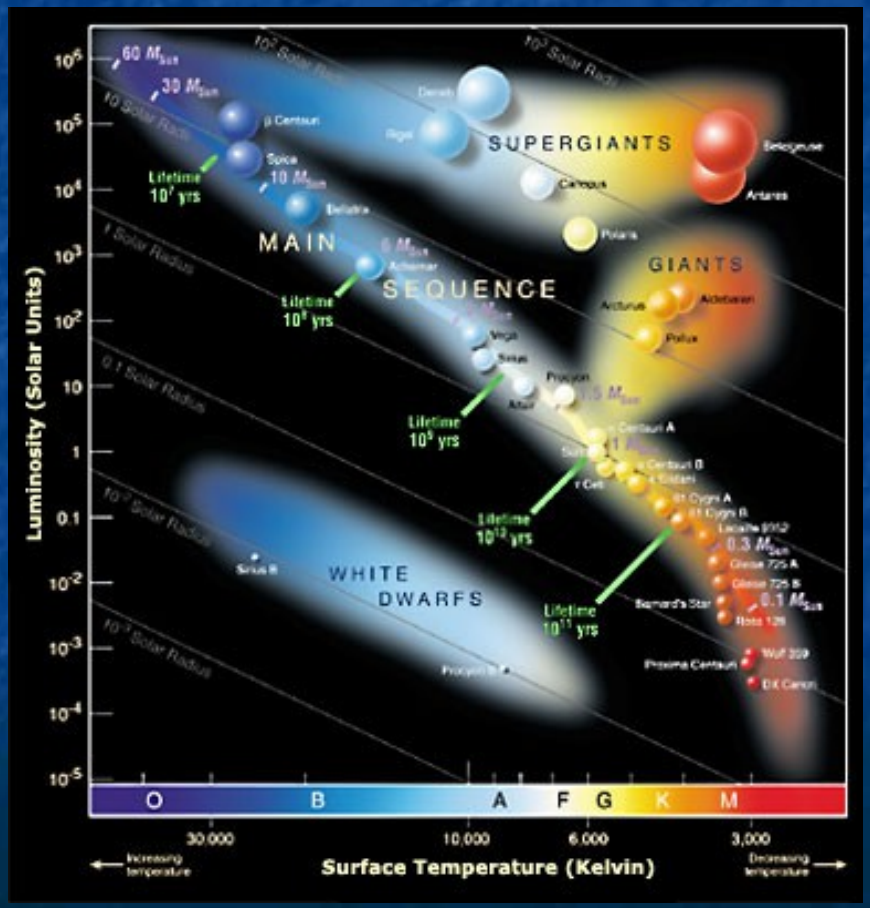
Stars also vary in temperature. The range of colors a star emits depends on its surface temperature. Analyzing the light emitted by a star helps us to determine the stars temperature.

Cooler surface temperatures (below 3900° C) results in a red coloring (for example, Betelgeuse). Hotter temperatures change the color to orange, then yellow (our sun, at about 5500° C), and then white. The hottest stars (such as Sirius) have a bluish white color (above 9500° C).

The Hertzsprung-Russell Diagram*

About 90% of all stars seem to fit in a band that runs from the upper left of the diagram to the lower right. This band is called the main sequence. The stars in this band are called main-sequence stars.

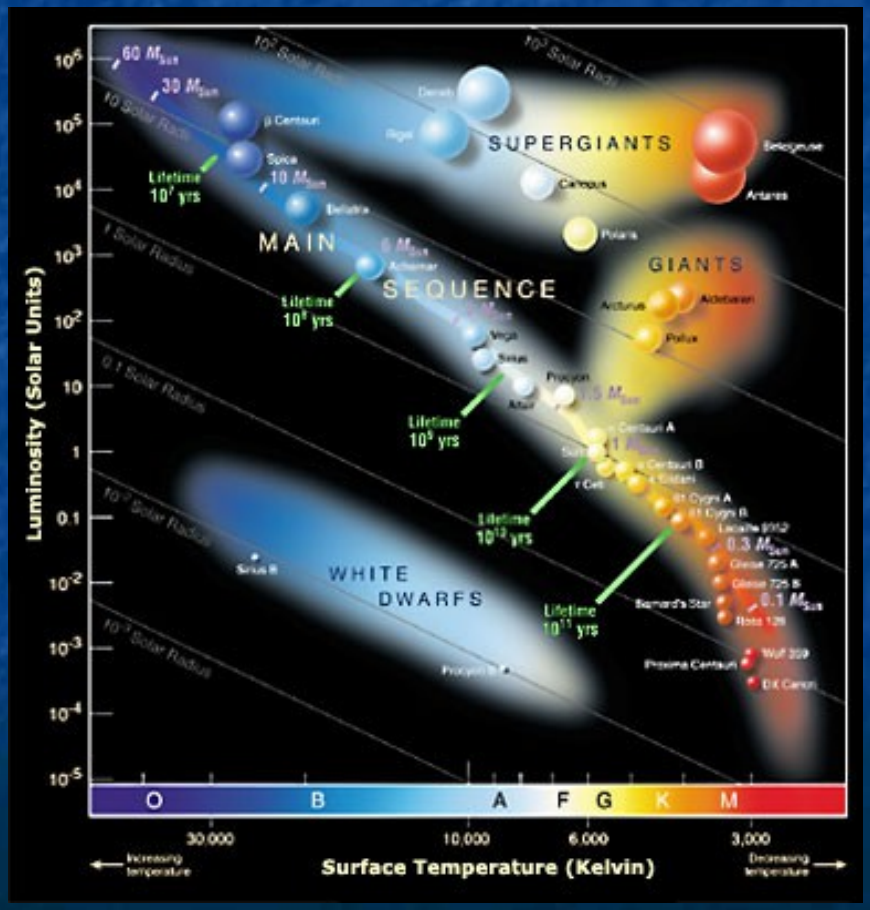
Main-sequence stars vary in surface temperature and absolute magnitudes. However, all main-sequence stars are actively fusing hydrogen into helium.



The Hertzsprung-Russell Diagram*

Above the main-sequence stars are giant stars. Giant stars are more luminous and have diameters from 10-100 times greater than our sun.

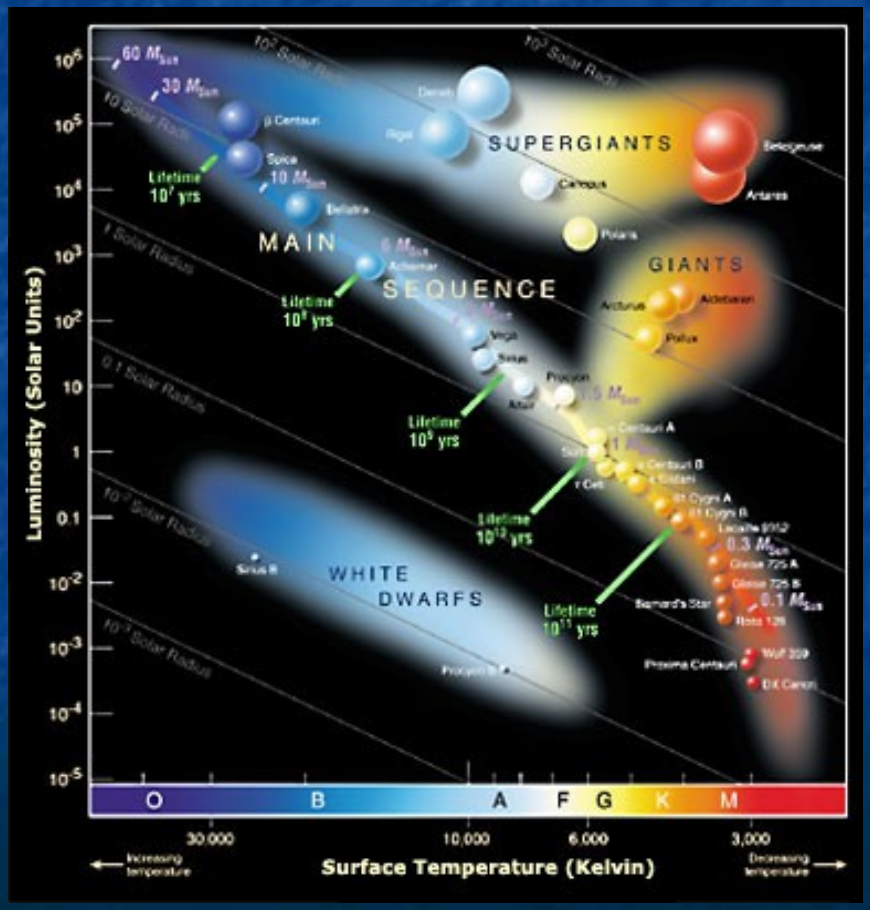
Super giants are giant stars that have diameters more than 100 times greater than our sun. These giant stars (but relatively cool) are very luminous.



The Hertzsprung-Russell Diagram*

Also included on the H-R diagram are white dwarfs. These are stars that are near the end of their lives. These were once red giant stars that have lost their outer atmosphere and are now only a glowing stellar core.

Red giant that loses outer atmosphere = white dwarf



White Dwarfs