12.6: Low-Mass Stars

Low-Mass Stars fuse hydrogen into helium, the proton-proton cycle. The classic low-mass star is the Sun. Low-mass stars have large convection zones when compared to intermediate- and high-mass stars. In **very low-mass stars**, the Convection Zone goes all the way to the star's core!Over time, a low-mass star consumes all of the hydrogen in its core – *what happens now?* Think about a car that runs out of gas. Unless you put more gas in the tank, the car will not run. The same is true with stars; no more fuel in the stellar core will end the stellar fusion process.

When the core hydrogen is used up and no more nuclear fusion occurs, the star's outer stellar layers expand and the core shrinks. At this point, the star becomes a **Subgiant Star**. The star's outer layers continue to expand and the star brightens. The star then becomes a **Red Giant Star**. In about one billion years, the Sun will begin its Red Giant phase.

So how does the star expand and get brighter if it has ceased to fuse hydrogen in its collapsing core? Helium is left in the star's core and gravity continues to shrink the core and the surrounding layers. These surrounding layers contain hydrogen; the surrounding shell of hydrogen begins to fuse, called **Hydrogen Shell Burning**. The now red giant star is now larger than out to the orbit of Mars.

Next, helium fusion begins, for which very high temperatures are required.

$$^{3}\mathbf{He} \rightarrow {}^{12}\mathbf{C}$$

This occurs when three helium nuclei are fused into one carbon.

The star begins to dim and shrink in size. Now the cycle *reverses* ; hydrogen and helium are fused at a tremendous rate. This process takes a few million years. Now the star's outer layers flow outward from the star, with the star's core is mostly composed of carbon (from the fusion of the remaining helium into carbon).