10.6: A “Quick Guide” to Solar Fusion—The Proton-Proton Cycle

Two protons fuse to yield deuterium, which fuses with a proton to form He-3. This fuses with another He-3 to form He-4, two protons, and a lot of energy is produced and released during this process. The Proton-Proton Cycle is for *less-massive* stars, like the sun.

Eighty-five percent of the sun’s energy comes from this type of reaction; other reactions include:

1. A He-3 atom and a He-4 atom combine to form a beryllium-7 ($4p^{+} + 3n^{0}$) and a γ
2. A Be-7 atom captures an e- to become lithium-7 atom ($3p^{+} + 4n^{0}$) and a neutrino
3. A Li-7 combines with a p+ to form two He-4 atoms

It appears that the sun has used about 50% of its Deuterium. So, what happens when the sun uses 100% of its Hydrogen? *The Proton-Proton Cycle will continue until the sun runs out of Hydrogen.* This is much like a car running out of gas – unless you can syphon fuel from another car (or another star).

How do we know that Solar Fusion happens? We look for the neutrinos from the fusion process by counting the actual number of neutrinos received versus the calculated number of neutrinos expected.

More-Massive Stars

For stars more massive than the sun, the Proton-Proton cycle can still occur, but another reaction sequence becomes more favorable for converting hydrogen to helium. It is called the **CNO cycle** ;**C** arbon- **N** itrogen- **O** xygen. These stars are ~1. 33 solar masses or larger with the final fusion end product being the element iron, Fe. The process goes no further because iron cannot be fused due to its binding energy.