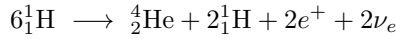
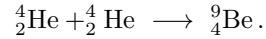


# Nuclear Fusion in Stars

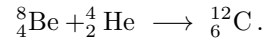
Within stars, the most common fusion reaction is the proton-proton chain, which is a series of reactions that convert hydrogen into helium. The overall reaction is:



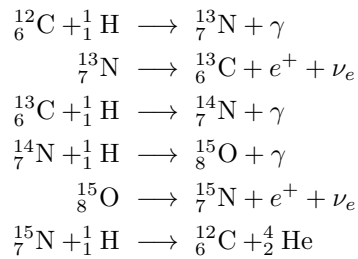
Once enough helium has been produced, the helium nuclei themselves will have an appreciable chance of fusing. Two helium nuclei can undergo the interaction



However, this is extremely unstable and will quickly undergo the reverse reaction with a lifetime of around  $10^{-16}$  s. If, however, the  ${}_4^8\text{Be}$  nucleus collides with another helium nucleus before it decays, it can undergo the reaction

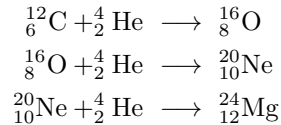


When enough carbon has been formed, a new cycle can begin in which  ${}_6^{12}\text{C}$  becomes a catalyst for the formation of  ${}_2^4\text{He}$  in the following chain:

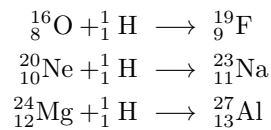


The carbon acts as a catalyst; the  ${}_6^{12}\text{C}$  atom is consumed in the first reaction and regenerated in the last. The total energy released in this cycle is the same as in the proton-proton chain, but in the carbon cycle slightly more of that energy is lost via the neutrinos. However, the rate of the carbon cycle is much higher than the proton-proton chain.

Once the core of the star heats sufficiently, further reactions can occur to create heavier elements:



If these atoms are ejected into the cooler regions of the star, where the proton-proton cycle is still dominant, then they can capture protons to form elements with odd  $Z$ :



As the core of the star heats further, these heavier nuclei can combine to form even larger elements, up to and including  ${}_{26}^{56}\text{Fe}$ . However, we find that elements heavier than iron are not formed in stars via fusion.