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11/27/23

Astron-98

Modeling PP Energy Generation in Stars

Originally this project was going to be looking at both the PP and CNO cycle that are found in stars. I thought this would be interesting because we'll see where one model ends and another kicks in. This however was pretty complex and didn't work well, the fit that I would get doesn't show cleanly.

The PP cycle is an energy generation that has to do with two hydrogen molecules coming together through fusion and making helium. This is what makes energy for stars and keeps that star in hydrostatic equilibrium. However eventually the PP chain tempers off and the CNO chain continues and makes heavier elements.

$$\epsilon_{pp} = 5 \times 10^5 \rho X^2 \, T_7^{-2/3} e^{-15.7 \cdot T_7^{-1/3}} \text{ erg g}^{-1} \text{ s}^{-1}$$

$$\epsilon_{cno} = 1.8 \times 10^{27} \rho X Z \, T_7^{-2/3} e^{-70.7 \cdot T_7^{-1/3}} \text{ erg g}^{-1} \text{ s}^{-1}$$

Figure 1: Energy rate from the pp chain and CNO chain per unit mass

What I did was I took the equation above for the PP chain and used it as a model for energy generation in stars as a function of mass. At first I put in hypothetical masses to see how reasonable my model was. The data it gave me showed that the higher the mass the higher the energy generation became with a few dips here and there. This makes logical sense because the PP chain has a density in the model. Higher the mass, higher the density, higher the energy generation.

This model didn’t work for stars higher than a certain mass and lower than a certain mass. 0.1 solar mass doesn't make sense for the PP chain because anything below this doesn't get to a high enough temperature to ignite fusion. After a certain mass CNO chain becomes more dominant. So my steps for applying a quality filter was to limit my data between 0.1 solar mass to 5.5 solar masses.

I took my data from the MIST website and used an isochrone data sheet, this is because these stars are just starting out and we should see the PP chain in action. Using several lines of data from the website I was able to apply it to my model and see the results. Since the model was used from an accurate equation, the model had no need for a fit error.