lecture 28  Not too heavy stars: evolution (< 10 M☉)

General idea: fusion consumes and transforms $H \rightarrow He \rightarrow \ldots$ "metals" heavy elements

Stars with $M < 10 M☉$ have deep convection and thus He core remixed with $H$ at the outside

- Ne shell ignites
- Enough and dense in the core ignite
- 1 $\rightarrow$ 2 $M$ burning
- For low mass $\sim 1 M☉$
- 1 $\rightarrow$ 3 $M$ burn

released energy goes to expansion

Log $T_e$ Log $L$ Note: shell and core somewhat decoupled, one contracting, another expanding

$4 \rightarrow 5$ Convection develops so very efficient delivery of energy to surface $\Rightarrow$ LA RGB

Elements past He seen in Hα photosphere

p. 6. $M < 1.8 M☉$ core collapse

a lot of $\beta$ escape and carry energy from the core so its $L^\downarrow$ but shells flatten with $M_2$, the flash $L \sim 10^8 L☉$
Heavier stars burn He and switch to CNO → horizontal branch (HB)

Thermal pulsating shell He drops at core L < Rehery then R down new chunk of He to core, and cycle repeats.

For M > 2M☉ 3rd dredge up (remix)
Carbon storge mixed to photosphere

Eventually shell & seite burning and pushed away (planetary nebula), opacity drops and we see central core (white dwarf).
Stars reuse the previous star materials

So we have

\[
\begin{align*}
\text{Population} & \rightarrow \text{metal poor} \\
-1 & \rightarrow \text{metal pure} \\
1 & \rightarrow \text{metal rich}
\end{align*}
\]

If we have a cluster

\[ R \rightarrow \frac{R}{\tau} \]

We can make HR diagram which shifted along L so by scaling to our galaxy NR we can find the distance to cluster

\[ \Rightarrow \text{spectroscopic parallax} \]

Age of cluster by turn off - isochrones in HR diagram

\[ \log L \rightarrow \text{the lighter star the older the cluster} \]