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ILT 2 WEEKS 5–6

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1. TASK A

For this task, I have selected Aldebaran, or α Tauri, a K5III spectral type giant. Its radius can be estimated from the Stefan-Boltzmann equation that connects star's luminosity, temperature and radius:

$$L = 4\pi R^2 \sigma T^4 \tag{1}$$

Dividing this equation by the same equation related for the Sun (Freedman et al. 2014), we get the constant σ cancelled out:

$$\frac{L}{L_\odot} = \left(\frac{R}{R_\odot}\right)^2 \left(\frac{T}{T_\odot}\right)^4 \tag{2}$$

Rearranging terms for radius:

$$\frac{R}{R_\odot} = \left(\frac{T_\odot}{T}\right)^2 \sqrt{\left(\frac{L}{L_\odot}\right)} \tag{3}$$

Using the known $L/L_\odot = 518$ and $T = 3910$K for Aldebaran (Piau et al. 2011), and $T_\odot = 5800$K, we find Aldebaran's radius as the function of solar quantities:

$$\frac{R}{R_\odot} = \left(\frac{5800\text{K}}{3910\text{K}}\right)^2 \sqrt{518} = 50.08 \tag{4}$$

Once a star like Aldebaran has finished burning hydrogen in its core, it leaves the main sequence and enters the red giant phase. In this phase, it begins burning the hydrogen shell surrounding the inert helium core. The core collapses inward under gravity, heats up, increases in temperature and adds energy to the helium-fusing shell surrounding it. This, in turn, increases pressure on the outer layers of the star, making it grow in size. The outer layers become further apart from the core, cool down and the star becomes less hot on the surface. A red giant is expected to spend a few hundreds of millions of years in this phase.

2. TASK B

The difference between a red giant and an AGB star is that the AGB star has all the helium burning in its core finished. It begins burning the helium shell around the inert core that increases the star's pressure and size, and decreases its temperature, similarly to when this star has ascended the H-R diagram from the main sequence to become a red giant. A time the star spends on the AGB branch is a fraction of its total lifetime, ∼1–15 million years (Engels 2005), or about a hundred times less time spent in the red giant phase. The reason the star evolves so quickly on the AGB branch is very high rate of mass loss, eventually stripping star's envelope and leaving behind only the C-O core at the end of this phase.

3. TASK C

The thermal pulsing (TP) cycle occurs at the final stages of the star's evolution on the AGB branch in which it remains only several hundred thousand years. Each cycle lasts about several hundred years during which AGB stars loose their masses because of the high-density helium accumulating in the shell and igniting in a flash, releasing large amounts of energy. At the end of multiple cycles, only the star's naked core remains which marks the star's departure from the AGB branch.

REFERENCES

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