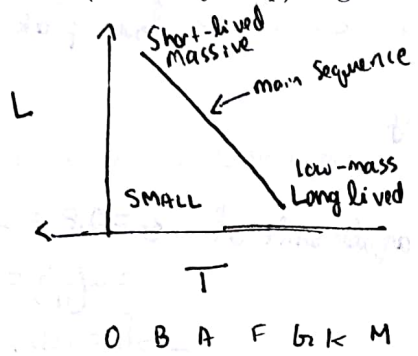
Stars[1]

1. You observe a main sequence star that has 3 times the mass of the Sun. What is its luminosity, in solar luminosities?

$L \propto M^4 \rightarrow \left(\frac{L}{L_\odot}\right) = \left(\frac{M}{M_\odot}\right)^4 \rightarrow L = L_\odot \left(\frac{3M_\odot}{M_\odot}\right)^4 = 81\,L_\odot$

2. Draw an HR (luminosity-temp) diagram. Label your axes.



→ because they're bright but not very hot

$L = 4\pi R^2 \sigma T^4$

   (a) What else could I plot along the x-axis?
   (b) Label where O stars live.
   (c) And M stars.
   (d) Where do the largest stars (by radius/diameter) live? And the smallest?
   (e) The longest lived MS stars? Shortest lived?
   (f) The most massive MS stars? Least massive?

3. Star A is twice as hot as Star B, and also twice the distance away from us. Their radii are the same. How do the apparent brightnesses of the two stars compare?

$L_A = 16\,L_B$ (because $L \propto T^4$)

$b = \frac{L}{4\pi d^2}$

$\frac{b_A}{b_B} = \frac{L_A}{L_B}\frac{d_B^2}{d_A^2} = 16 \cdot \left(\frac{1}{2}\right)^2 = 4$

A is 4 times brighter than B.

4. Star A has three times the mass of Star B. Both are on the main sequence and are at the same distance away from us. What is the ratio of their apparent brightnesses in this case? What if I now move Star A twice as far away as Star B?

if they are at same distance, then ratio of apparent brightnesses = ratio of luminosities.

Ratio of luminosities is just $\left(\frac{L_A}{L_B}\right) = \left(\frac{M_A}{M_B}\right)^4 = 81$

Now move Star A twice as far away. This decreases its apparent brightness by a factor of 4 relative to B, so new ratio of apparent brightness is $\frac{81}{4}$.

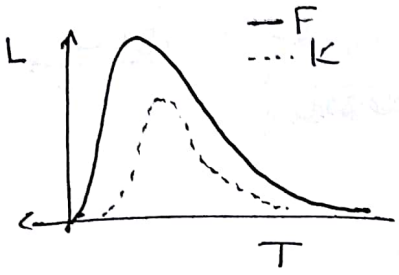
5. Which would have a hotter main-sequence turn-off, an open or globular cluster?

Open. The MS turn-off is the star that's just about to finish its MS life. Open clusters are younger, → therefore they will have more massive ★s still on MS, more massive MS ★s are hotter.

Remember, more massive MS ★s die first!

[1] Finally!

6. Which will have a longer peak wavelength of its spectrum, an F or K star? *Sketch* the spectra (intrinsic brightness vs. wavelength) for these two stars.



O B A F G K M

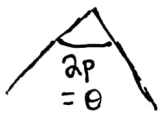
← increasing T

So F stars hotter ⟷ lower peak λ

I did not draw the absorption lines, for simplicity.

7. What is the maximum distance away an object can be from you at which you could still measure the distance to the object using its parallax?

This one is tricky!



Need to be able to resolve an angular shift of $\theta = 2p = \frac{\lambda}{D}$

$= 2\left(\frac{1}{d}\right) = \frac{\lambda}{D}$

$\rightarrow \boxed{d = 2D/\lambda}$

8. What is the lifetime of a main sequence star three times the mass of the Sun?

$t_{MS} \propto \frac{1}{M^3} \rightarrow \frac{t_{MS}}{t_{MS,\odot}} = \left(\frac{M_\odot}{M}\right)^3 \cdot \underbrace{10^{10}\ \text{yrs}}_{\text{= MS lifetime of Sun}} = \boxed{\frac{10^{10}\ \text{yrs}}{27}}$

9. No self-respecting astronomer doesn't have their own personal mnemonic[2] to remember the spectral types of the Sun (OBAFGKM) – so think up your own! A prize goes out to the best one next week (as determined **100% subjectively** by yours truly)...

[2] acronym? I don't know, I can never remember the difference