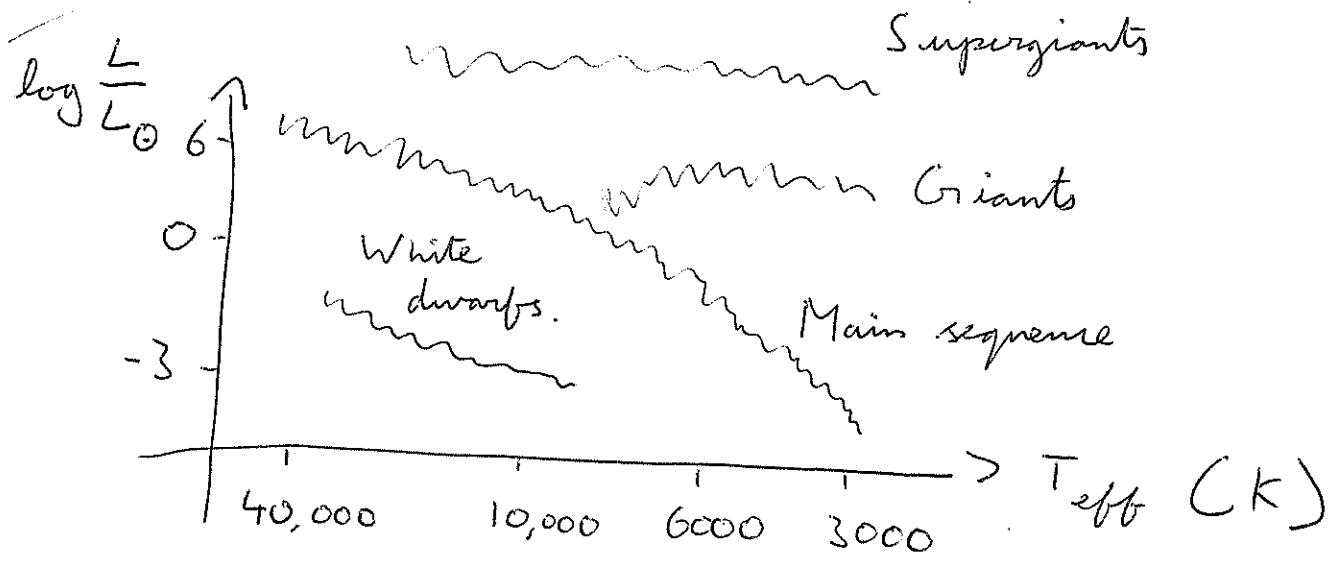


# Aug 20 #12 - The H-R Diagram

The theorists version:



Lines of constant radius:  $L \propto R^2 T_{\text{eff}}^4$ .

The main sequence is steeper than  $T_{\text{eff}}^4$ !

But that's enough about theory. How do observers make H-R diagrams?

\* Replace  $T_{\text{eff}}$  with color index or spectral class. Blackbody peaks: 3000 K  $\rightarrow \lambda \sim 1 \mu\text{m}$ .

10,000 K  $\rightarrow \lambda \sim 3000 \text{ \AA}$ . Optical bands

B  $\sim 4450 \text{ \AA}$ , V  $\sim 5510 \text{ \AA}$ , G  $\sim 4640 \text{ \AA}$ ,

R  $\sim 6580 \text{ \AA}$ , I  $\sim 8060 \text{ \AA}$ .

Thus, e.g.,  $B-V > 0$  (in magnitudes!)

for  $T_{\text{eff}} \lesssim 10,000 \text{ K}$ ,  $R-I > 0$  for

$T_{\text{eff}} \lesssim 5,000 \text{ K}$ , etc.

The observer's H-R diagram is a color-magnitude diagram (CMD).

(move on spectral class in the next lecture).

\* Measuring luminosities requires the distance modulus

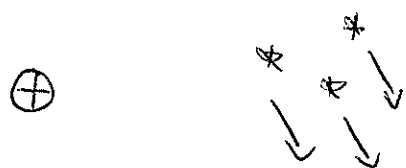
$$\begin{aligned} m - M &= 5 \log_{10} d_{\text{pc}} - 5 \\ &= 5 \log_{10} \left( \frac{d}{10 \text{ pc}} \right). \end{aligned}$$

Direct distance measures ...

Parallax.  $D (\text{pc}) = \frac{1}{\theta (\text{arcsec})}$  ↖ parallax.

Moving clusters

TOP



②

SKY



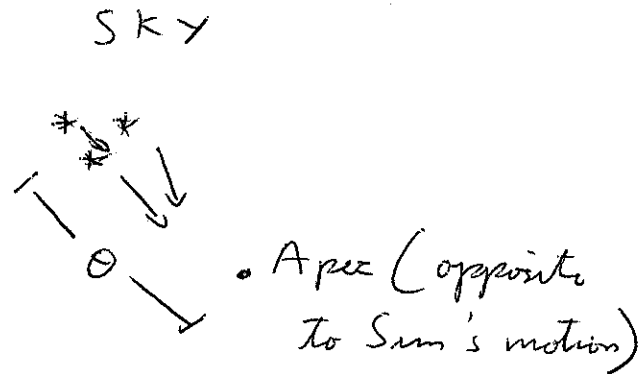
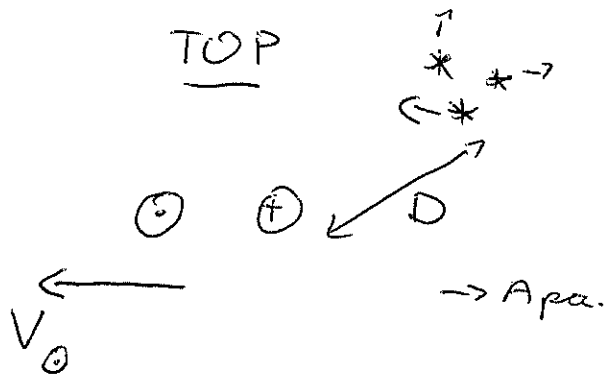
Given transverse and radial velocities  $V_T$  &  $V_R$ ,  
and a convergent point @  $\Theta$  approached  
at  $\dot{\Theta}$ ,

$$D = \frac{V_T}{\dot{\Theta}}$$

$$V_T = V_R \tan \Theta$$

from Doppler shifts.

### Secular parallax



In this case,  $\dot{\Theta} = \frac{V_{\odot}}{D} \sin \Theta$ , so  $D = \frac{V_{\odot}}{\dot{\Theta}} \sin \Theta$ .

$\left( \frac{\sin \Theta}{\dot{\Theta}} \right)$  is derived statistically from large stellar groups.

### Statistical parallax

Gives stars with measured scatter in radial

and proper velocities ( $\sigma_R$  &  $\sigma_\theta$  respectively),  
The distance can be estimated as

$$D \sim \frac{\sigma_R}{\sigma_\theta}.$$

### Spectroscopic parallax

Once you know the spectral class of a star, you can estimate its luminosity from the H-R diagram (or models)  $\rightarrow$  distance!