**INST 2403 Activity**

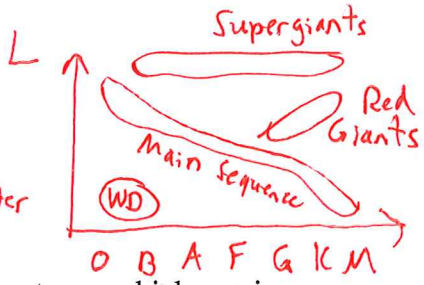
# Hertzsprung-Russell Diagrams

Hertzsprung-Russell diagrams are two-dimensional plots of stellar properties with luminosity (or equivalent) on the vertical axis and spectral type (or equivalent, like temperature) on the horizontal axis. As an example, consider the star **Aldebaran (αTauri)** in the diagram below. Aldebaran is spectral type K5 and 160 times more luminous than the sun. The first letter is the spectral type: K (one of the OBAFGKM sequence), the Arabic number (5) is like a second digit to the spectral type, so K0 is very close to G, K9 is very close to M.

1. A list of stars is given below. Put them into the Hertzsprung-Russell diagram.

   **α Centauri** (1.5 $L_{sun}$, G2); **Sirius A**(25.4 $L_{sun}$, A1); **Sirius B** (0.056 $L_{sun}$, A2); **Betelgeuse** (120,000$L_{sun}$, M2), **Regulus** (288$L_{sun}$,B8); **61 Cygni** (0.153 $L_{sun}$, K5); **Procyon** (6.93$L_{sun}$, F5); **Deneb** (200,000 $L_{sun}$, A2); **Proximate Centauri** (0.002$L_{sun}$, M6).

2. Sometimes stars are classified according to their general luminosity classes. Describe the following classes, circle or indicate the region in the HRD and give one example chosen from the stars above.
   a. Supergiants (I) very luminous
   b. Red Giants (III) luminous, cool
   c. Main sequence stars (V) varying temp. & lum.; hotter = brighter
   d. White dwarfs (WD) hot & dim




3. The spectral classes correspond to different surface temperatures, which are, in turn, related to different colors following Wien's law. Assign a temperature and color to each spectral type by adding two more horizontal axes to the HRD. Possible colors: white, bluish, bluish-white, yellow, red, blue, orange. Possible temperatures: 3000K, 30,000K, 10,000K, 4000K, 6000K, 8000K, 20,000K.

| | | | | | |
|---|---|---|---|---|---|
| O | 30,000 K | blue | G | 6000K | yellow |
| B | 20,000K | bluish | K | 4000 K | orange |
| A | 10,000K | bluish-white | M | 3000K | red |
| F | 8,000 K | white | | | |

4. By which factor does the temperature of stars vary?
   10 : from 3000K to 30,000K

5. By which factor does the luminosity of stars vary?
   from 200,000 $L_\odot$ to 0.002 $L_\odot$
   so $10^8$ or 100 million

(Temp & Luminosity)

6. How are the two correlated if at all?

For main sequence stars: higher temperature means (much) higher luminosity

7. What could the reason be that stars have so different luminosities, given that they are all made essentially of the same stuff, namely hydrogen and some helium?

Size & mass

8. Do all stars of the same temperature have the same luminosity? Explain with an example.

No, Sirius B & Deneb are both A2 stars, but one is million times more luminous than the other.