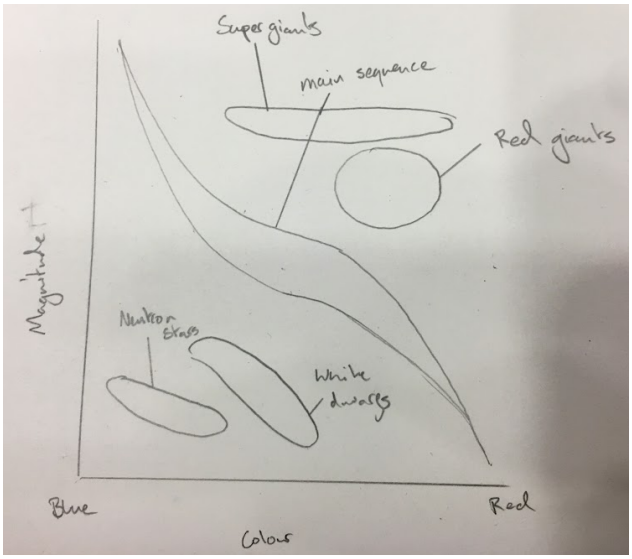
Year 1 Coursework Set 3

1. Sketch a colour-magnitude diagram for nearby stars, annotating where on the diagram key populations of stars are found.



2. The Earth receives 1 380 W m^{-2} of energy from the Sun. By comparison, a nearby main sequence star has a measured flux of 2.7×10^{-8} W m^{-2} and a measured parallax angle of 0.05 arcsec. Given that main sequence stars follow an approximate mass-luminosity relation of the form

$$L \propto M^{3.5},$$

estimate the mass of the star (in solar masses).

$$F = \frac{L}{4\pi r^2}$$

$$r = \frac{1}{0.05} = 20pc$$

$$2.7 \times 10^{-8} = \frac{L}{4\pi(6.1713 \times 10^{17})^2}$$

$$L = 1.292 \times 10^{29} W$$

$$\frac{L}{L_\odot} = \frac{1.292 \times 10^{29}}{3.846 \times 10^{26}} = 336$$

$$336 = (\frac{M}{M_\odot})^{3.5}$$

$$\frac{M}{M_\odot} = 5.27$$

3. Two open clusters, A and B, lie physically close together a large distance away from us in the Milky Way. In Cluster A, the brightest main sequence (MS) stars have an apparent magnitude of 18, while in Cluster B they have an apparent magnitude of 24.

   Show that the brightest MS stars in Cluster A produce fluxes on Earth a factor of ~ 250 higher than those in Cluster B.

$$m_a - m_b = -2.5log(\frac{f_a}{f_b})$$

$$-6 = -2.5log(\frac{f_a}{f_b})$$

$$\frac{-6}{-2.5} = log(\frac{f_a}{f_b})$$

$$10^{2.4} = \frac{f_a}{f_b} = 251.18 \approx 250$$

4. The lifetime of a star on the main sequence, τ, obeys an approximate relation of the form

$$\tau \propto L^{-0.7}.$$

   By what factor in age are the stars in Cluster B older than those in Cluster A?

$$\frac{L_b}{L_a} = \frac{f_b}{f_a} = \frac{1}{250}$$

$$\frac{1}{250^{-0.7}} = \frac{\tau_b}{\tau_a} = 47.7$$