Stellar Astronomy and Astrophysics (SS12)

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Exercise 1 for April 24, 2012

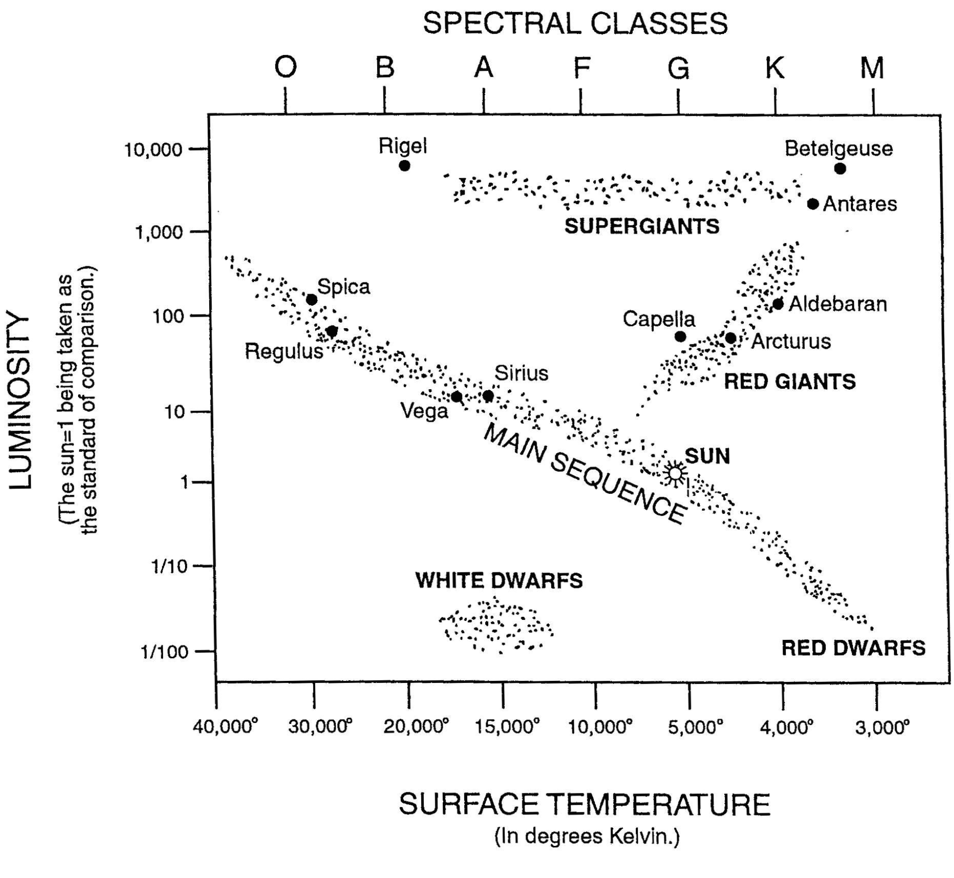
1.1 Number of Stars in the Milky Way

Does the Milky Way Galaxy contain more stars than there are grains of sand in the beach volleyball court at the Neckarwiese? Please justify your answer using simple order-of-magnitude estimates.

1.2 The Hertzsprung-Russel Diagram

The Hertzsprung-Russel diagram (HRD) illustrates the correlation between two fundamental properties of stars. These are their color (or surface temperature) on the abscissa and their brightness (luminosity) on the ordinate. For an excellent animation visit the following webpage: `http://www.spacetelescope.org/videos/heic1017b/`.

Take the HRD shown below and draw in the curves of stars with radii of $0.1R_\odot$, $1R_\odot$, $10R_\odot$, and $100R_\odot$. Assume all stars are perfect blackbodies, use the know relation between flux and surface temperature (Stefan-Boltzmann law), and take the geometric dilution factor between flux and luminosity into account.



1.3 Some Special Stars

Search the internet or other sources.

a: Find the closest and second closest star to Earth. What are their distances? How long did their light travel to us?

b: Find the brightest and second brightest star on the sky. What are their apparent magnitudes?

c: What is the most massive star known to date?

1.4 The Stellar IMF

Additional Assignment: The distribution of stellar masses at birth in the solar neighborhood can be described by the following functional form:

$$\xi(m) = \begin{cases} 0.26m^{-0.5} & \text{for} \quad 0.01 < m \leq 0.08 \\ 0.035m^{-1.3} & \text{for} \quad 0.08 < m \leq 0.5 \\ 0.019m^{-2.3} & \text{for} \quad 0.5 < m < 100. \end{cases}$$

The quantity $\xi(m)dm$ indicates the number of objects per cubic parsec, pc^3, in the mass interval m to $m + dm$, with mass m given in units of solar mass $M_\odot$. Objects with $m < 0.08$ are brown dwarfs. Their mass is too small for hydrogen burning in the center. Stars with $m > 100$ are not stable.

a: The quantity $\xi(m)$ is the differential number density in the (linear) mass interval m to $m + dm$. Often, however, it is better to consider the differential number density ξ_L in the (logarithmic) mass bin $\log_{10} m$ to $\log_{10} m + d \log_{10} m$. Calculate ξ_L and plot $\log_{10} \xi_L$ versus $\log_{10} m$.

b: What is the average stellar mass?

c: Sirius is the brightest star on the sky. Actually, it is a binary system, with Sirius A being 2.1 times heavier than the Sun (with a spectral type A1V) and Sirius B being a white dwarf. The system is at at distance of ≈ 2.6 pc. How many stars with the mass of Sirius A and heavier do you expect within a distance of 10 pc from the Sun?