COLOUR-COLOUR DIAGRAMS

Link to: physicspages home page.

To leave a comment or report an error, please use the auxiliary blog.

Reference: Carroll, Bradley W. & Ostlie, Dale A. (2007), *An Introduction to Modern Astrophysics*, 2nd Edition; Pearson Education - Chapter 3, Problem 3.15.

We can use the colour indices of a star to determine its magnitudes in the three colour regions of ultraviolet, blue and visual. From Appendix G in Carroll & Ostlie, we have, for the Sun:

$$M_{bol} = +4.74 \tag{1}$$
$$BC = -0.08 \tag{2}$$
$$M_V = +4.82 \tag{3}$$
$$U-B = +0.195 \tag{4}$$
$$B-V = +0.650 \tag{5}$$

We can get the absolute magnitudes from

$$M_B = (B-V)+M_V = +5.47 \tag{6}$$
$$M_U = (U-B)+M_B = +5.665 \tag{7}$$

We can get the apparent magnitude from the relation

$$m = M + 5\log d - 5 \tag{8}$$

where d is the distance in parsecs. The Sun has

$$d = 1 \text{ AU} = 4.848137 \times 10^{-6} \text{ pc} \tag{9}$$

so

$$V = M_V + 5(\log d - 1) \tag{10}$$
$$= +4.82 + 5\left(\log\left(4.848137 \times 10^{-6}\right) - 1\right) \tag{11}$$
$$= -26.752 \tag{12}$$

The other two apparent magnitudes are

$$B = (B-V)+V = -26.102 \tag{13}$$

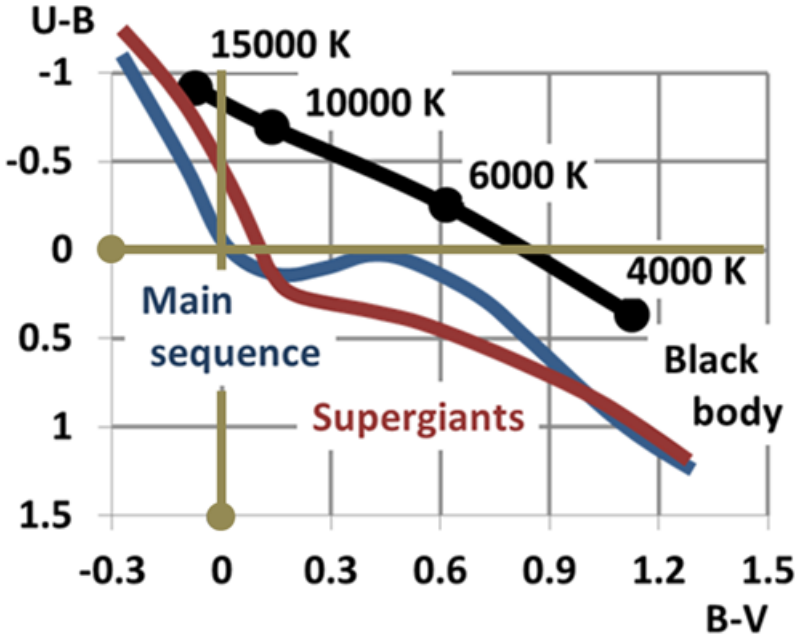
$$U = (U-B)+B = -25.907 \tag{14}$$

For Sirius, the colour indices are measured as (from Example 3.6.1 in Carroll & Ostlie):

$$U-B = -0.04 \tag{15}$$

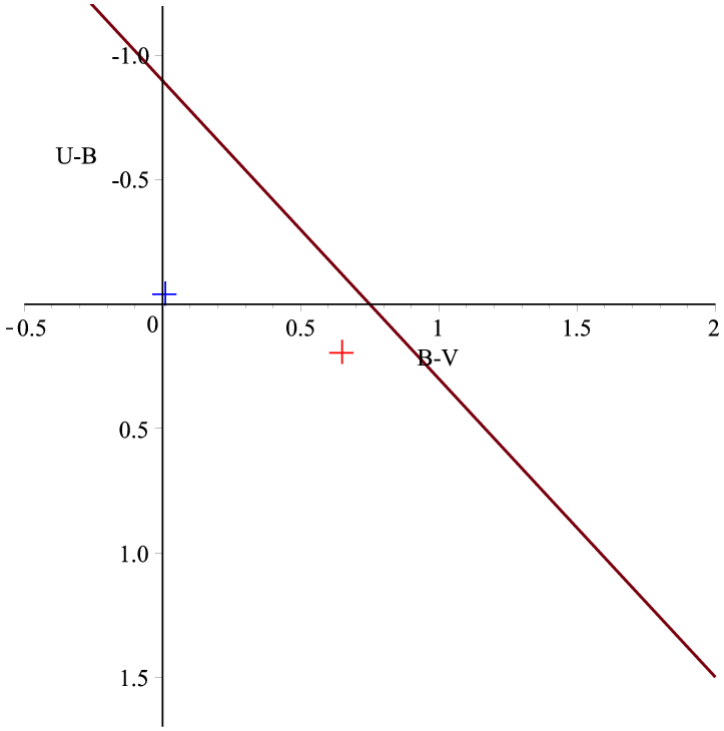
$$B-V = +0.01 \tag{16}$$

The two colour indices can be plotted on a diagram called a *colour-colour diagram* in which the vertical axis is $U-B$ (increasing downwards) and the horizontal axis is $B-V$ (increasing to the right). A typical colour-colour diagram is shown here (this diagram is by Brews ohare, from the Wikipedia page on the colour-colour diagram):



Main sequence stars comprise the majority of 'normal' stars in the galaxy; supergiant stars are, as the name implies, very large stars. The black line shows the ideal curve for blackbodies. The hottest stars are on the left, ranging through intermediate temperatures to the coolest stars in the lower right. In general, most stars lie below the blackbody curve, indicating that their $U-B$ values are larger than a blackbody at the same temperature. That is, most stars tend to have an excess of blue light over ultraviolet light as compared to a similar blackbody.

If we plot the Sun and Sirius on a colour-colour diagram, we get:



Again, the straight line is the blackbody curve. The red cross is the Sun and the blue cross (near the origin) is Sirius. Sirius lies to the left of the Sun, so it is hotter.