COLOUR-COLOUR DIAGRAMS

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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:

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

Remember that a lower number indicates a brighter star, so if a colour index such as $U - B$ is positive, it means that the ultraviolet magnitude M_U is higher than the blue magnitude M_B, which in turn means that the star is brighter in the blue region of the spectrum.

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

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

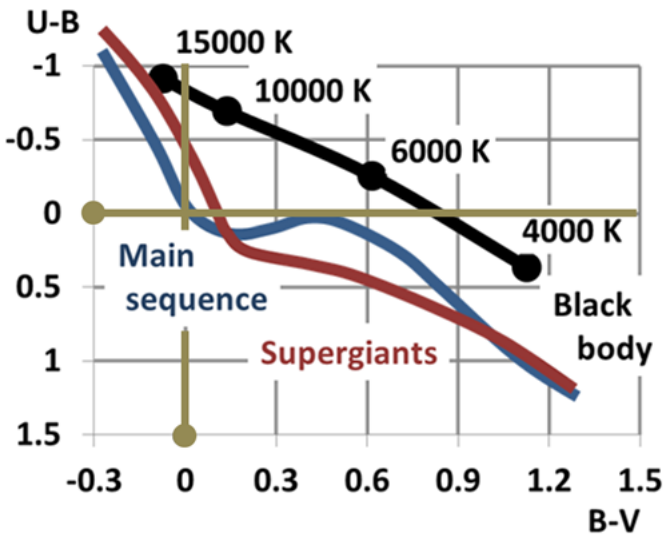

FIGURE 1. Colour-colour diagram. (Credit: Brews ohare, from the Wikipedia page on the colour-colour diagram.)

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 in Fig. 1.

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.

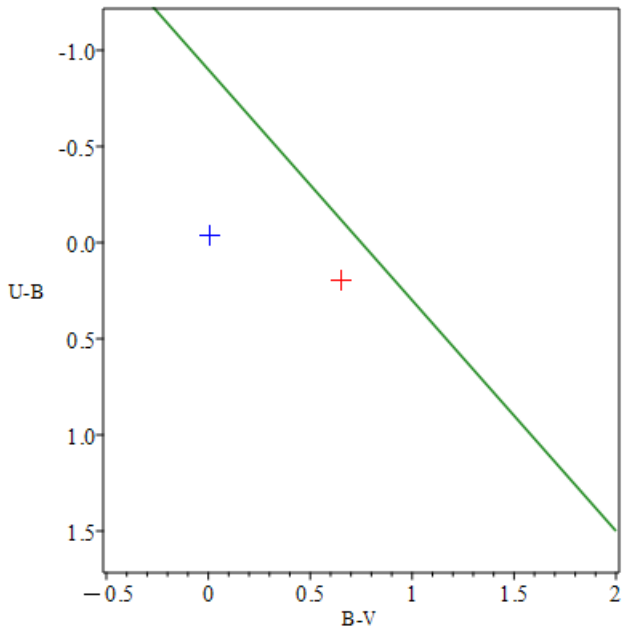

FIGURE 2. Sun (red cross) and Sirius (blue cross) on a colour-colour diagram. The green line is the blackbody curve.

If we plot the Sun and Sirius on a colour-colour diagram, we get Fig. 2. Sirius lies to the left of the Sun, so it is hotter.