Stellar Properties
Brightness and Distance

1. A red star and a blue star have the same radius and are the same distance from the Earth. Which appears brighter in the night sky?

   Blue star (hotter, higher luminescence)

2. What is the approximate temperature of a G5 star? What is its expected color? What are the prominent absorption lines?

   ~5,500 K

3. Repeat question 2 with an A0 star.

   ~11,000 K

4. Vega (α-Lyr) is 25.3 ly from Earth. The photometric brightness of Vega is 3.353 x 10^{-8} W/m^2. What is the brightness of Vega when viewed from 10 pc?

$$F = \frac{L}{4\pi d^2} \quad \text{so...} \quad \frac{F_{\text{far}}}{F_{\text{close}}} = \frac{\frac{L}{4\pi d_{\text{far}}^2}}{\frac{L}{4\pi d_{\text{close}}^2}} = \left(\frac{d_{\text{close}}}{d_{\text{far}}}\right)^2$$

$$F_{\text{far}} = 3.353\times10^{-8}\ {}^{\text{W}}\!/_{\text{m}^2}\left(\frac{25.3\text{ ly}}{32.6\text{ ly}}\right)^2 = 2.019\times10^{-8}\ {}^{\text{W}}\!/_{\text{m}^2}$$

5. Antares (α-Sco) is 604 ly from Earth and has an apparent visual magnitude of 1.06 making it the 15th brightest star in the Earth's sky. What is the absolute magnitude of Antares?

$$m - M = 5\log d - 5 \quad (d \text{ in pc; } M = \text{absolute magnitude})$$

$$d = 604\text{ ly}\times\frac{1\text{pc}}{3.26\text{ ly}} = 185\text{pc}$$

$$1.06 - M = 5\log d - 5$$

$$M = -5.28$$

6. Arcturus (α-Boo) has an apparent magnitude of –0.05 (photometric brightness = 3.4 x 10^{-8} W/m^2), making it the 3rd brightest star in the Earth's sky. Carefully characterizing the star and using a Hertzsprung-Russell diagram it is found that the star is classified K2III with an absolute magnitude of –0.31 (luminosity = 4.3 x 10^{28} W). Based upon this information, how far away is Arcturus?

$$L = F(4\pi d^2)$$

$$d^2 = \frac{4.3\times10^{28}\,\text{W}}{4\pi(3.4\times10^{-8}\,\text{W/m}^2)} = 1.01\times10^{35}\,\text{m}^2$$

$$d = 3.17\times10^{17}\,\text{m}$$

$$d = 3.17\times10^{17}\,\text{m}\times\frac{1\,\text{ly}}{9.461\times10^{15}\,\text{m}} = 33.5\ \text{ly}$$

…or…

$$m - M = 5\log d - 5$$

$$-0.05-(-0.31) = 5\log d - 5$$

$$d = 11.3\ \text{pc}$$

$$d = 11.3\ \text{pc}\times\frac{3.26\ \text{ly}}{1\ \text{pc}} = 36.7\ \text{ly}$$

7. The brightest star in Cygnus (the Swan) is Deneb with an apparent magnitude of 1.25. Based upon its spectral characteristics and temperature, its absolute magnitude is determined to be –8.73. How far away is Deneb from Earth?

$$m - M = 5\log d - 5$$

$$1.25-(-8.73) = 5\log d - 5$$

$$d = 991\ \text{pc}$$

$$d = 991\ \text{pc}\times\frac{3.26\ \text{ly}}{1\ \text{pc}} = 3230\ \text{ly}$$

8. Draw the typical Hertzsprung-Russell diagram. Accurately label the axes and identify the regions.

9. The apparent magnitude of Regulus (α-Leo A) is 1.36. Approximately how far away, in ly, is Regulus from Earth? Refer to a Hertzsprung-Russell diagram for any necessary additional data regarding Regulus.

$$m - M = 5\log d - 5$$
$$m = 1.36$$
$$M \cong -0.5 \text{ (from the H-R diagram)}$$
$$1.36 - (-0.5) = 5\log d - 5$$
$$d = 24 \text{ pc}$$
$$d = 24 \text{ pc} \times \frac{3.26 \text{ ly}}{\text{pc}} = 77 \text{ ly}$$

10. A star is judged to be a main-sequence star by virtue of its absorption line spectrum. Its V-B color ratio is 1.50 and its apparent magnitude is 8.6. Approximately how far away from Earth is this star?

$$T \cong 6300 \text{ K (from B-V/Temp diagram)}$$
$$M = +4.2 \text{ (main sequence star on H-R diagram)}$$
$$m = 8.6$$
$$8.6 - 4.2 = 5\log d - 5$$
$$d = 76 \text{ pc} = 247 \text{ ly}$$

11. The parallax angle of Vega (α-Lyr) is 0.129 arcsec. How far away is Vega?

$$d = \frac{1}{p} = \frac{1}{0.129''} = 7.75 \text{ pc (=25.3 ly)}$$