Homework 9

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September 2021

1. Absolute Magnitude: $m - M = 5\log(\frac{d}{10})$. According to the colorful diagram, an M0 Ib star has absolute magnitude of about -4. Therefore,

$$\begin{aligned} m - M &= 5\log(\frac{d}{10}) \\ 1 - (-4) &= 5\log(\frac{d}{10}) \\ d &= 100\text{pc} \end{aligned}$$

2. Stefan-Boltzmann Law: $L \propto R^2T^4$. Sun temp: $6000k$, Radius $R_\odot$, Mass $M_\odot$. Then for an M0 V star

$$\begin{aligned} L &= (\frac{R_{M0V}}{R_\odot})^2(\frac{T}{6000k})^4 \\ 10^{-2} &= (\frac{R_{M0}}{1})^2(\frac{4400}{6000})^4 \\ R_{M0V} &= 0.19R_\odot. \end{aligned}$$

   And for an M0 Ia star,

$$\begin{aligned} L &= (\frac{R_{M0Ia}}{R_\odot})^2(\frac{T}{6000k})^4 \\ 10^5 &= (\frac{R_{M0Ia}}{1})^2(\frac{4400}{6000k})^4 \\ R_{M0Ia} &= 588.03R_\odot. \end{aligned}$$

3. Stefan-Boltzmann Law: $L \propto R^2T^4$. Betelgeus(4000k, M0 Ib), luminosity: $10^{3.5}$

   (a)

$$\begin{aligned} \frac{10^{3.5}}{10^2} &= (R)^2(\frac{4000}{4000})^4 \\ R &= 5.62 \text{ times larger} \end{aligned}$$

(b)

$$\frac{10^{3.5}}{10^{4.2}} = (R)^2(\frac{4000}{25000})^4$$
$$R = 17.448 \text{ times larger}$$

(c)

$$\frac{10^{3.5}}{1} = (R)^2(\frac{4000}{5800})^4$$
$$R = 118.23 \text{ times larger}$$