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ASTRONOMY 1102 - Section 1

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Spring 1998

Homework # 4 due Fri. Feb. 26

Main Sequence and Variable Stars

1) A B3V star has a mass of approximately 10 $M_\odot$. Estimate its luminosity in solar luminosities $L_\odot$, using the approximate mass-luminosity relationship discussed in class: $L \propto M^3$. Then use Fig.25-7 to get an estimate for the luminosity using absolute magnitudes. Compare.

According to $L \propto M^3$, the L of a 10 $M_\odot$ star is $L = (10)^3 L_\odot = 1{,}000\ L_\odot$. According to Fig. 25-7, the absolute magnitude of a 10 $M_\odot$ star is approximately M = -5, which is 10 magnitudes brighter than the sun and therfore corresponds to $L = 10{,}000\ L_\odot$.

2) Using the Mass-Radius relationship discussed in class $R \propto M$, estimate the radii of a 5 $M_\odot$ and of a 0.5 $M_\odot$ star. Which is densest on average? In other words, if I take a cubic inch of material from the center of each star , which is likely to contain more mass? HINT: average density = mass/volume.

The density is $\propto M/R^3$. Since $R \propto M$, that means that the density is $\propto M/R^3 \propto M/M^3 \propto 1/M^2$. So, the smaller the mass, the higher the density of main sequence stars. The average density of a 5 $M_\odot$ star is 25 times less dense than the sun, while a 0.5 $M_\odot$ star is 4 time more dense than the sun.

3) A cepheid of period 50 days is observed by the Hubble Space Telescope to oscillate around an apparent magnitude of 24 in a distant spiral galaxy. How far is that galaxy approximately? HINT: use Fig. 25-11.

According to Fig. 25-11, a Cepheid with a period of 50 days has an absolute magnitude of about - 6. Consequently the distance modulus is m - M = 30. Since m - M = 0 for 10 pc, and the distance increases by a factor of 10 for every 5 magnitudes, the distance to the galaxy must be about $10^6 \times 10pc = 10$ Mpc.

NOTE: 30/5 = 6, so a factor of 10 every 5 magnitudes yields 10^6.