Astronomy 12 — Spring 1999 (S.T. Myers)

Homework Set 7

Due Thursday April 8, 1999 (5pm)

1. The period-luminosity relationship for classical Cepheid variable stars is

$$\log \frac{L}{L_\odot} \approx 1.15 \log P(\text{days}) + 2.47$$

Use this and the absolute visual magnitude of the Sun (+4.83) to derive a relation between the absolute visual magnitude M_V and period P of a Cepheid.

Use the distance modulus to derive the relation between the distance (in pc) and the apparent visual magnitude m_v and period P.

Polaris has an apparent visual magnitude of $m_v = 2.3$ and is a Cepheid with a period of $P = 13$ days. What is the absolute visual magnitude of Polaris, and what is its approximate distance in parsecs?

2. Consider a set of two Cepheid variable stars, with masses, radii, and absolute visual magnitudes as given below:

$M/M_\odot$	$R/R_\odot$	M_v	Period (days)
5	36.3	-3.1	
10	195.0	-5.9	

Use the period vs. density relationship for pulsating stars

$$P = \left[\frac{3\pi}{2\gamma G\rho}\right]^{1/2}$$

with $\gamma = 4/3$ to calculate the expected periods (in days) and fill in the table.

Assume that Cepheids follow a relationship of the form

$$M_v = a \log P(\text{days}) + b$$

and solve for the constants a and b using our calibrator stars given above. (Note that this relation may be different than the one given above!)

We observe a Cepheid variable with a period of 20 days and an apparent visual luminosity of $m_v = 10.4$. What is the distance to the star in parsecs?

3. The star Mira is a long-period variable (LPV) star with a period of 400 days. The average absolute bolometric of Mira magnitude is $M_{bol} = -5$, and the average temperature is 2300 K. What is the radius of Mira (in $R_\odot$)? Where (what branch or sequence) in the H-R diagram does Mira lie?

During its 400 day period, Mira brightens by 5.1 magnitudes while at the same time it temperature goes from 2000 K to 2600 K. What ratio of maximum to minimum radius does this imply for a radial pulsation?

4. Consider stars with all the same luminosity L distributed uniformly through space. Show that the number-flux counts follow the relation $N(> f) \propto f^{-3/2}$, where $N(> f)$ represents the number of stars visible in the sky with an apparent flux greater or equal to f.

5. The circular rotation velocity of the disk of our galaxy is approximately constant at 220 km/s. Use simple power-law scaling arguments to derive the mass density law $\rho(r)$ implied by this constant rotation velocity with radius from the galactic center. What is the scaling for the enclosed mass $M(< r)$?