
Stellar Astronomy and Astrophysics (SS12)

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Exercise 9 for June 26, 2012

9.1 Period-Luminosity relation for Cepheids:

In the lecture we derived

1. the period-density relation $P \propto \rho^{-1/2}$,
 2. A Mass-Luminosity relation $L \propto M^\alpha$,
 3. and have shown that the instability strip for pulsation is restricted to a narrow strip of almost constant T_{eff} in the HRD.
- a) If we assume that for Cepheids $\alpha = 4$ (a somewhat higher value than for main-sequence stars), show that a period-luminosity relation ($\log L$ vs. $\log P$) exists. Hint: Use Stefan-Boltzmann's law.
- b) Assume that the instability strip is not at $T_{\text{eff}} = \text{const.}$ but more accurately given by $\log L = \beta \log T_{\text{eff}} + \delta$. How does the period-luminosity function look like in this case?
- c) Is this relation sufficient to determine the distance of a Cepheid from measuring its period and an apparent magnitude?

9.2 Cepheids in M100:

Several remote classical Cepheids were discovered in 1994 by the Hubble Space Telescope in M100, which is a member of the Virgo cluster. The Fig. 2 from a paper by Freedman et al. (1994) shows the period-luminosity relation for these Cepheids. Use the two Cepheids nearest the figure's best-fit line in the upper panel (for the V magnitude) to estimate the distance to M100. Use the period-luminosity relation

$$M_V = -2.81 \log_{10} P_d - 1.43, \quad (1)$$

where M_V is the average absolute V magnitude and P_d is the pulsation period in units of days. The mean visual extinction is $A_V = 0.15 \pm 0.17$ magnitudes for the M100 Cepheids. Compare your result to the distance of 17.1 ± 1.8 Mpc obtained by Freedman et al.

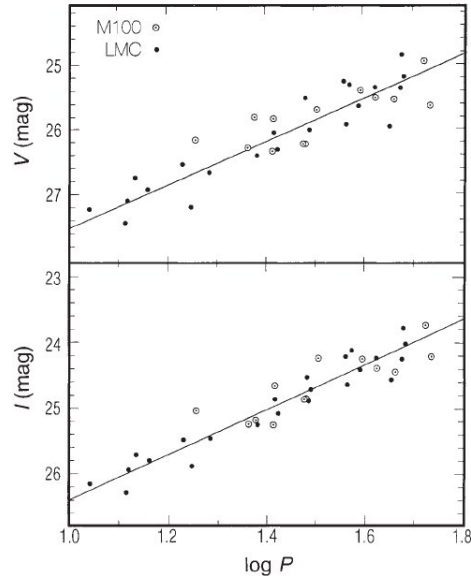


FIG. 2 Composite period-luminosity relations (V-band upper panel; I-band lower panel) for Cepheids in M100 (white circles) and Cepheids in the LMC (black circles, shifted to the distance of M100). Apparent V and I distance moduli for M100 are obtained by minimizing the residuals in the combined P - L relations for the two galaxies, and determining the relative offset with respect to the calibrating LMC sample. Consistent with previous studies^{3,20}, only high signal-to-noise variables (those having an average of their absolute deviations from the mean exceeding 1.5 times the mean error) are plotted, whereas only stars with $\log P < 1.8$ are included in the fit. The difference in the V and I apparent moduli for M100 is assumed to be due to interstellar dust present both in M100 and our own galaxy. Correcting for this effect yields a reddening-corrected (true) distance to M100 of 17.1 ± 1.8 Mpc.