THE CEPHEID LUMINOSITY SCALE

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The distances of clusters containing classical Cepheids are central to the calibration of the period-luminosity relation. As a step in improving the reliability of the calibration, uvbyβ photometry was obtained for B stars in eight of these clusters. These data were then used to determine the distances of the clusters and, thus, the absolute magnitudes of the Cepheids and the zero point of the PLC relation (See Schmidt 1984 for details).

The chief difference among various Cepheid luminosity calibrations is in the zero point. Following de Vaucouleurs (1978), we can use the quantity $< M_V(0.8) >$, the absolute magnitude implied by a PLC relation at log P = 0.8 and a color of $<B>_0 - <V>_0 = 0.65$, to intercompare them. In Table 1 we summarize values of $< M_V(0.8) >$ for several types of calibrations. It can be seen that the zero point for the Cepheid luminosity scale covers a range of more than 0.6 magnitudes. The present calibration and those based on main-sequence fitting of UBV photometry are at nearly opposite ends of this range. The reasons for the disagreement are discussed in detail by Schmidt (1984) where it was argued there that the values based on four-color and Hβ photometry are the more reliable.

Table 1
Zero Points of PLC Relations

Method	$< M_V (0.8) >$	References
uvbyβ	-3.50 to -3.55	1
Radii	-3.71 to -3.81	2
Main-sequence fitting	-3.75 to -3.92	3
Theory	-3.86 to -4.14	4

References for Table (listed in order of the derived value of $<M_V(0.8)>$)
1. Schmidt (1984), Balona & Shobbrook (1984).
2. Martin et al. (1979), Stothers (1983), Barnes (1979).
3. Caldwell (1983), van den Bergh (1976), deVaucouleurs (1978), Sandage & Tammann (1969), Fernie & McGonegal (1983).
4. Cox (1979), Stothers (1983).

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With the luminosities of the cluster Cepheids from the uvbyβ photometry and temperatures based on Pel's (1978) scale, pulsational masses were calculated from the theoretical expressions of Cox (1979). The pulsational masses are 50% of the evolutionary masses for periods near 4 days and increase to about 75% of the evolutionary mass for periods around 10 days. Although this is a relatively small range in period, the difference in slope between the evolutionary masses and the pulsational masses is obvious in a plot of log M vs. log P (see Figure 5 of Schmidt 1984). An inspection of masses based on the larger distance scales (see for example the masses given by Cox(1979) shows the same slope difference for stars in common.

The small pulsational masses are a result of the small distance scale proposed here and, as many authors have discussed, the pulsational masses and the evolutionary masses are in agreement for the larger luminosity scales. However, the present pulsational masses are in good agreement with the masses inferred from the beat periods of double-mode Cepheids and with the masses inferred from the secondary bumps on velocity curves of Cepheids with periods near 10 days if standard models are used for both. Thus, the present luminosity scale produces consistency among the various masses from pulsation theory while the evolutionary masses are discrepant. This suggests that the attempts to reconcile the various masses individually with the evolutionary masses may have been misdirected. The disagreement is possibly more fundamental and may need to be rectified by improvements to either the theory of stellar evolution or to the theory of stellar pulsation.

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