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A THEORETICAL PERIOD-LUMINOSITY RELATION OF DWARF CEPHEIDS

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Dwarf Cepheids (large-amplitude δ Sct variables and SXPhe variables in the GCVS) are late A-type stars near light maximum and early-F stars near light minimum. In the lower part of the instability strip where these stars are found the pulsation constant Q varies only slightly. As pointed out by Andreasen, Hejlesen, and Petersen (1983) this makes it easy to transform a theoretical HR or alternatively a ($\log T_e$, $\log g$) diagram to a theoretical ($\log T_e$, $\log P_0$) diagram by the use of the $P_0\sqrt{\rho}=Q$ relation. This follows from the equations:

$$\log P_0 = \log Q + 1.5 \log R/R_\odot - 0.5 \log M/M_\odot \quad (1)$$

$$\log g = \log g_\odot + \log M/M_\odot - 2 \log R/R_\odot, \quad (2)$$

where P_0 is the fundamental period of pulsation. The periods, of course, can be determined with very high accuracy.

For a given chemical composition Z, the evolutionary tracks of stellar models provide a direct means to calibrate ($\log T_e$, $\log P_0$) as a function of mass. To this end we have utilized the models of both Mengel et al. (1979) and VandenBerg (1985) to produce evolutionary tracks in ($\log T_e$, $\log P_0$) diagrams as a function of mass and chemical composition Z for an assumed helium abundance, $Y = 0.25$. The two sets of models give similar results. With the aid of the period and the effective temperature, T_e, the mass and also the bolometric magnitude can be inferred from the ($\log T_e$, $\log P_0$) diagram and position of the star in the traditional HR diagram. We have utilized published photometry, primarily $uvby\beta$ and Kurucz (1988), atmosphere models to estimate the mean effective temperature of the stars. Bolometric magnitudes of 25 dwarf Cepheids have been determined and the results are shown in Figure 1 where $M_{\rm bol}$ is plotted as a function of $\log P_0$. The open squares represent our values as inferred from the periods and effective temperatures at mean light. The solid line is the period-luminosity relation given by the equation

$$M_{\rm bol} = -3.762 \log P_0 - 2.007 \quad (3)$$

based on a least-square solution.

We also have plotted as solid squares the bolometric magnitudes of 14 metal-poor variables with light amplitude $\geq 0.^m25$ found in globular star clusters (Nemec and Mateo 1990).

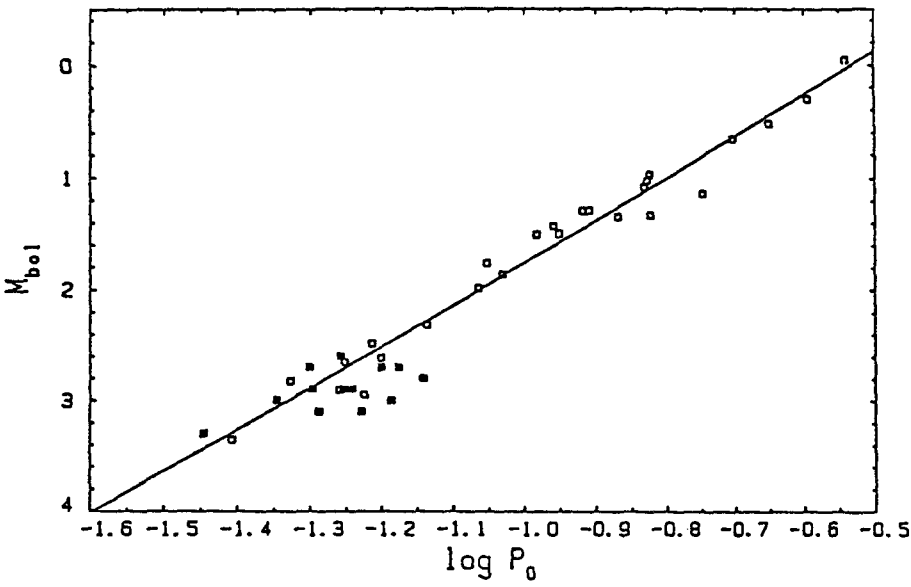

Fig. 1 - Theoretical period - luminosity relation of dwarf Cepheids. Open squares are $M_{\rm bol}$ values derived from models and the (P_0, T_e) values of the variables. The solid squares are $M_{\rm bol}$ values of metal-poor variables found in globular star clusters.

A bolometric correction of $-0.^m2$ has been applied to the M_v values given by Nemec and Mateo. The M_v values were determined by fitting HR diagrams of the stars in the cluster to standard HR diagrams. Note that the observed $M_{\rm bol}$ values are $\sim 0.^m2$ fainter than the theoretical curve. The origin of this small discrepancy is unknown at the present time.

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