Period Shifts in RR Lyrae Stars

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Using recently published infrared photometry of RR Lyrae stars from both the field (Fernley *et al.* 1992) and globular clusters (Longmore *et al.* 1990), period shifts have been calculated using the mean $(V-K)$ colour rather than the mean $(B-V)$ colour employed in most previous analyses (e.g., Sandage 1990 and references therein). The advantage of using $(V-K)$ rather than $(B-V)$ is the reduced sensitivity to, firstly, metallicity and, secondly, non-LTE radiation. This latter occurs in many RR Lyrae stars near maximum light and clearly should not be included when calculating the mean colour and hence, mean temperature. This, and all other aspects of the present paper, are discussed more fully in Fernley (1992a).

The mean $(V-K)$ colour of both the field and cluster stars were de-reddened using the maps of Burstein and Heiles (1982) and converted to effective temperature using the calibration of Fernley (1989). The resulting period – $< T_{\rm eff} >$ plots are shown in Figure 1 for the field stars, where – as can be seen in Figure 1 – the stars have been divided into four metallicity bins. The metallicities of both the field and globular cluster stars have been taken from the literature. They are on the Preston (1959) ΔS scale as calibrated into [Fe/H] by Butler (1975).

It can be seen in Figure 1 that there are several discrepent stars and these have been excluded from the least-squares fits. Of particular interest is BB Vir which, on the basis of its colour being too blue and it having a large ultraviolet excess, has been proposed as a binary with a blue-horizontal-branch companion (Kinman and Caretta 1992; Fernley 1992b).

Similar plots were made for the RR Lyrae stars in M3, M5 and M15. For both the field and cluster stars, the period at log $T_{\rm eff} = 3.81$ was read off and those periods are shown plotted against [Fe/H] in Figure 2. It can be seen that the periods of the field stars are systematically displaced above the globular cluster stars; the effect being particularly large at the metal-poor end.

Similar plots were made for the RR Lyrae stars in M3, M5 and M15. It has been suggested recently by Carney *et al.* (1992) that there is a bias in the field stars in the sense that an unrepresentative number of evolved stars are included. This bias arises because field stars were selected by the original observers (e.g., Fitch *et al.* 1966; Lub 1977) to cover a wide range of periods at a given metallicity. To test this further, we have calculated the mean period at a given metallicity for RR Lyrae stars from three samples: (1) the globular cluster stars used in this analysis, (2) the field stars from this same analysis, and (3) the field stars discovered in the Lick Survey (e.g., Suntzeff *et al.* 1991 and references therein). These mean periods are shown in Table 1, where it can be seen that the suggestion of Carney *et al.* (1992) is confirmed.

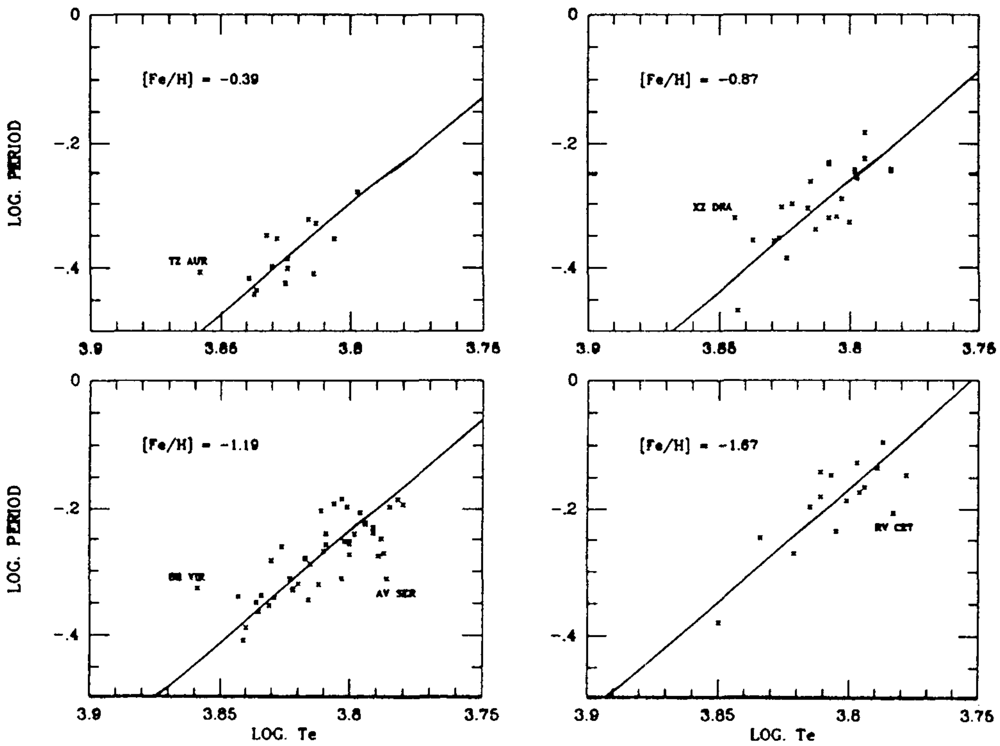

Figure 1. Period–colour diagrams at four different metallicities.

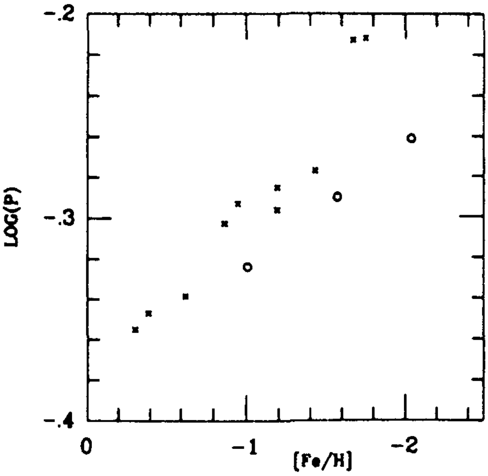

Figure 2. Period shifts (crosses = field stars; open circles = cluster stars)

Table 1. Mean periods at different metallicities

[Fe/H]	Cluster Stars	Field Stars (This Paper)	Field Stars (Lick Survey)
−1.03	0.518 (19)	0.515 (30)	0.532 (36)
−1.51	0.546 (22)	0.569 (39)	0.560 (44)
−1.83	0.566 (16)	0.654 (16)	0.576 (22)

Note: The number of stars used to derive the mean period is shown in brackets.

Omitting therefore the point from the most metal-poor stars, the best-fit lines to the data in Figure 2 give

$$\frac{d(\log P)}{d[\mathrm{Fe/H}]} \propto -0.073 : \text{field stars} \tag{1}$$

$$\frac{d(\log P)}{d[\mathrm{Fe/H}]} \propto -0.062 : \text{cluster stars} \tag{2}$$

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