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The metallicity dependence of the Cepheid period-luminosity relation

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Abstract. We have assessed the influence of the stellar iron content on the Cepheid Period-Luminosity (*PL*) relation by relating the *V* band residuals from the Freedman at al (2001) *PL* relation to [Fe/H] for 68 Galactic and Magellanic Cloud Cepheids. The iron abundances were measured from FEROS and UVES high-resolution and high signal-to-noise optical spectra. Our data indicate that the stars become fainter as metallicity increases, until a plateau or turnover point is reached at about solar metallicity. This behavior appears at odds both with the PL relation being independent from iron abundance and with Cepheids becoming monotonically brighter as metallicity increases (e.g. Kennicutt et al 1998; Sakai et al 2004).

Key words. Stars: abundances – Stars: distances – Cepheids

1. Introduction

The Cepheid Period-Luminosity (*PL*) relation is undoubtedly a fundamental tool in determining Galactic and extragalactic distances. In spite of its paramount importance, to this day we still lack firm theoretical and empirical assessment on whether or not chemical composition has any significant influence on it.

We have tackled the problem by measuring the chemical composition of a total of 68 Cepheids in the Milky Way galaxy and in the Large and Small Magellanic Cloud from spectra collected with ESO's FEROS and UVES instruments. The sample and the data reduction and analysis are thoroughly described in Romaniello et al (2005) and Mottini et al (2005,see also Mottini et al, this conference).

Our main results are summarized in Figure 1, where we plot the *V*-band residuals compared to the Freedman at al (2001) *PL* relation are plotted against the iron content measured from FEROS and UVES spectra for the 61 stars in our sample with well-determined distances and photometry and that populate the linear part of the *PL* relation ($0.4 \leq \log(P) \leq$

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1.85, e.g. Bono et al 1999). A positive $\delta(M_V)$ means fainter than the mean relation.

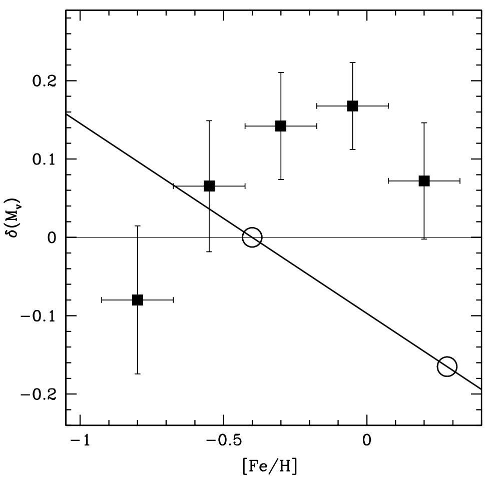

Fig. 1. The V-band residuals compared to the Freedman at al (2001) *PL* relation are plotted against the iron content measured from FEROS and UVES spectra. Filled squares represent the median value in each metallicity bin, with is associated errorbar. The metallicity dependence as inferred by Kennicutt et al (1998) from two Cepheid fields in M101 (open circles) is shown as a thick line.

In computing the $\delta(M_V)$ in Figure 1 we have adopted the periods, distance moduli and V-band photometry of the Galactic Cepheids as listed in Table 3 of Storm et al (2004). Two of our programme stars, ζ Gem and β Dor, are not included in that list and for them we have used the values from Groenewegen et al (2004,Table 3). The periods and V-band photometry for the Magellanic Cloud Cepheids were taken from Laney & Stobie (1994). The distance modulus of the barycenter of the LMC is assumed to be 18.50, for consistency with the *PL* relation of Freedman at al (2001). The SMC is considered 0.44 magnitudes more distant (e.g. Cioni et al 2000). Depth and projection effects in the Magellanic Clouds were corrected for using the position angle and inclination of each galaxy as determined by van der Marel & Cioni (2001,LMC) and Caldwell & Laney (1991,SMC).

As it can be seen in Figure 1 our data (filled squares) indicate that Cepheids become fainter as metallicity increases, until a plateau or turnover point is reached at about solar metallicity. This trend is at odds both with no dependence of the *PL* relation upon iron content (thin horizontal line) and with Cepheids becoming monotonically brighter as metallicity increases (Kennicutt et al 1998,thick line).

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