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Synthetic evolutionary models and pulsational constraints for metal-poor Cepheids.

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Abstract. In order to investigate the occurence of a Period-Luminosity relation for Anomalous Cepheids, we present synthetic evolutionary models to populate the pulsation Instability Strip discussed in (Marconi et al. 2004). We find that the evolutionary effects decrease as the wavelength increases, from the V to the K band. In particular the Period-Luminosity relation in the K band appears to be a robust distance indicator, as also happens for RR Lyrae stars.

Key words. Stars: evolution – Stars: oscillations – Satrs: Variables: Low-mass Cepheids

1. Introduction

Historically, ACs are considered "anomalous" because they do not appear to obey to the same Period-Luminosity (PL) relation of Classical Cepheids (CCs) nor of Population II Cepheids stars (Zinn & Searle 1976). In recent papers several authors (Dolphin et al. 2002; Clementini et al. 2003) have suggested that, from the observational point of view, these stars are not peculiar but the natural extension of CCs to lower metallicities. This suggestion is supported by our theoretical investigation see (Caputo et al. 2004; Marconi et al. 2004). In these papers, using a nonlinear pulsation code, we have explored the mass and luminosity ranges for these stars, for both fundamental and first overtone modes. As a result, we find that the AC pulsation properties, in particular the predicted Instability Strip (IS) in the M_V vs $\log P$ plane, follow the same behaviour of short-period CCs, as suggested by empirical evidences in the case of the dwarf irregular galaxy Leo A (Dolphin et al. 2002). In order to check if the similarity between Classical Cepheids and ACs also holds for the existence of a PL relation, to be used as distance indicator, we need to simultaneously investigate the evolutionary and pulsational properties of ACs to theoretically constrain the distribution within the IS.

2. Synthetic PL relations

The grid of evolutionary tracks used to build up synthetic populations of stars in the luminosity range of AC stars, is discussed in Fiorentino et

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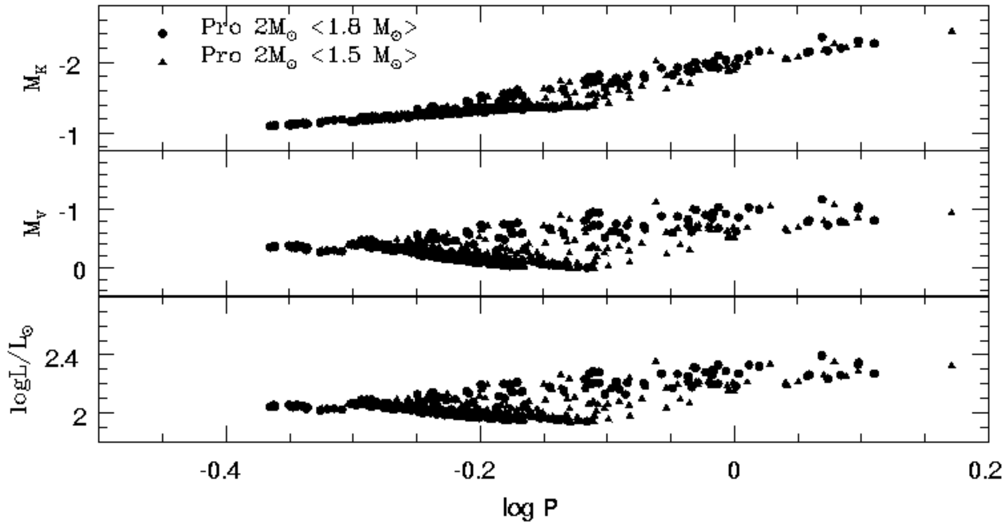

Fig. 1. The plotted distributions are obtained for a progenitor mass of 2 $M_{\odot}$, with the gaussians centred as labeled in top panel, in the log $L/L_{\odot}$(bottom panel), M_V (middle panel), M_K (top panel) vs log P planes

al. (in preparation). Here, we present some preliminary results obtained with synthetic populations derived for a progenitor mass of 2 $M_{\odot}$, with a mass loss gaussian distribution centered around 1.5 and 1.8 $M_{\odot}$. In Fig. 1, we show the IS synthetic distributions, in the log $L/L_{\odot}$(bottom panel), M_V (middle panel), M_K (top panel) vs log P planes. The boundaries of the IS are fixed using the results presented in (Marconi et al. 2004) and (Caputo et al. 2004), that are found to be almost independent of metallicity in the range $0.0001 \leq Z \leq 0.008$. Inspection of the bottom panel suggests that there is not a clear evidence of a PL relation, because at each luminosity level corresponds a large range of pulsation periods. This effect raises from the morphology of the evolutionary tracks inside the IS. Similary to the Zero Age Horizontal Branch for RR Lyrae stars, the Zero-Age turn over identifies an almost flat distribution. However, at variance with RR Lyrae, for each period, ACs can experiment evolutionary phases with a large range of luminosities inside the IS. The same behaviour can be observed in the M_V vs logP plane, while in the M_K vs logP plane the distribution is narrower and more linear. This different behavior at varying the wavelength, is due to the trend of the bolometric correction, which is almost independent of effective temperature in the visual band, but increases when the surface temperature decreases in the infrared bands (Bono et al. 2001).

3. Conclusions

Our theoretical results suggest that we cannot use a PL relation for low-mass Cepheids, at least in the Optical bands, whereas in the Near Infrared band a tigther correlation appears between these two parameters. For further details we remind the interested reader to a forthcoming paper (Fiorentino et al. in preparation).

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