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ORIGINAL ARTICLE

Luminosity–colour relations for red clump stars

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Abstract We calibrated the absolute magnitudes M_V, M_J, M_{K_s} and M_g of red clump stars in terms of colours. M_V and M_g are strongly dependent on colour, while the dependence of M_J and M_{K_s} on colour is rather weak. The calibration of the absolute magnitudes M_V and M_{K_s} is tested on 101 RC stars in the field SA 141. The Galactic model parameters estimated with this sample are in good agreement with earlier studies.

Keywords Stars: distances · Stars: late-type · Galaxy: fundamental parameters

1 Introduction

Red Clump (RC) stars are core helium-burning giants. They form a prominent feature in the colour–magnitude diagrams (CMDs) of open clusters. Following the prediction of Cannon (1970), it is known that they are abundant in the solar neighbourhood. In recent years much work has been devoted to studying the suitability of RC stars as a distance indicator. Their absolute magnitudes in the optical range lie from $M_V = +0.7$ mag for those of spectral type G8 III to $M_V = +1$ mag for type K2 III (Keenan and Barnbaum 1999). The absolute magnitude of these stars in the K_s band is $M_{K_s} = -1.61 \pm 0.03$ mag with negligible dependence on metallicity (Alves 2000), but with real dispersion. Based on observations of 14 open clusters with $-0.5 < [\mathrm{Fe/H}] \leq 0$ dex and $1.58 \leq t \leq 7.94$ Gyr, Grocholski and Sarajedini (2002) found that for RC stars in clusters have $\langle M_{K_s} \rangle = -1.61 \pm 0.04$ mag.

The dependence of the I band magnitude of RC stars on the metallicity and age was extensively studied in the past from an observational point of view. In most cases the I band-mean absolute magnitude is insensitive to age and metallicity. Udalski (2000) found that the M_I of RC stars weakly depends on metallicity. Paczyński and Stanek (1998) and Stanek and Garnavich (1998) found little or no variation in M_I with colour and metallicity. Sarajedini (1999) presented observations of eight open clusters, concluding that M_I is less sensitive to metal abundance than M_V, but that the dependence on age and metallicity is still not negligible. Zhao et al. (2001) and Kubiak et al. (2002) confirmed the results of Udalski (2000), and theoretical models from Girardi and Salaris (2001) also show a dependence in the I band, predicting that an older cluster with higher metallicity has fainter RC stars. Based on the model of Girardi et al. (2000), Salaris and Girardi (2002) stated that M_K is a complicated function of metallicity and age. For age $t > 1.5$ Gyr, it decreases with increasing metallicity, the opposite behaviour with respect to M_V and M_I absolute magnitudes.

Pietrzyński et al. (2003) have also investigated the dependence of the mean K, J and I absolute magnitudes of the RC stars on metallicity and age, as a part of their ongoing Araucaria Project to improve stellar distance indicators. They took deep near-infrared (NIR) J and K images of several fields in LMC, SMC and the Carina and Fornax dwarf galaxies and made a comparison between the

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