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The P-L relation in the BVRI bands for Cepheids in IC 1613

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Abstract. A set of six *BVRI* observations collected with the WFI at the ESO 2.2 m telescope have been used to derive multicolor data of Cepheids in IC 1613 identified in previous surveys. The method of Freedman has been applied to get reliable mean intensity values of Cepheid magnitudes in the various bands. The resulting slopes of the relations in the *BVI* bands are similar, within the uncertainties, to those previously obtained by other authors for the LMC.

Key words. Stars: Cepheids – galaxies: Local Group

1. Introduction

The mean magnitude of a Cepheid in a generic band can be estimated from just few observed points in that band and by using a complete light curve in another band as a reference or template. Freedman (1988) introduced this method to exploit old photographic light curves and few multiband CCD photometric points to discuss the distance modulus of the galaxy IC 1613. We applied such a method to obtain mean BVRI magnitudes of Cepheids using as templates V-band (Udalski et al. 2001) or white light Wh-band light curves (Antonello et al. 1998; Mantegazza et al. 2001) for the galaxies IC 1613 and NGC 6822. Here we present the preliminary results for the galaxy IC 1613.

The observations were performed with the WFI at the 2.2 m telescope at ESO LaSilla, in service mode, during six nights in 2000 and 2001, for a total of 6 data points in V and B band, 5 in R band and 4 in I band.

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2. Data analysis

The reduction was performed with IRAF, and each chip was treated separately. The I-band images were defringed. The profile photometry of the stars was obtained with DAOPHOT and ALLSTAR programs. The standard stars were not completely sufficient for an accurate calibration, and the photometry of the fields of IC 1613 observed by Cole et al. (1999) and Udalski et al. (2001) was then also adopted. Most of OGLE and our previously discovered Cepheids were identified in the WFI images. The available data sets were merged to improve the known period P. Since our purpose was to discuss the PL relations using the most accurate data and avoid first overtone contamination, we considered only 52 fundamental mode Cepheids with P longer than 2.7 days.

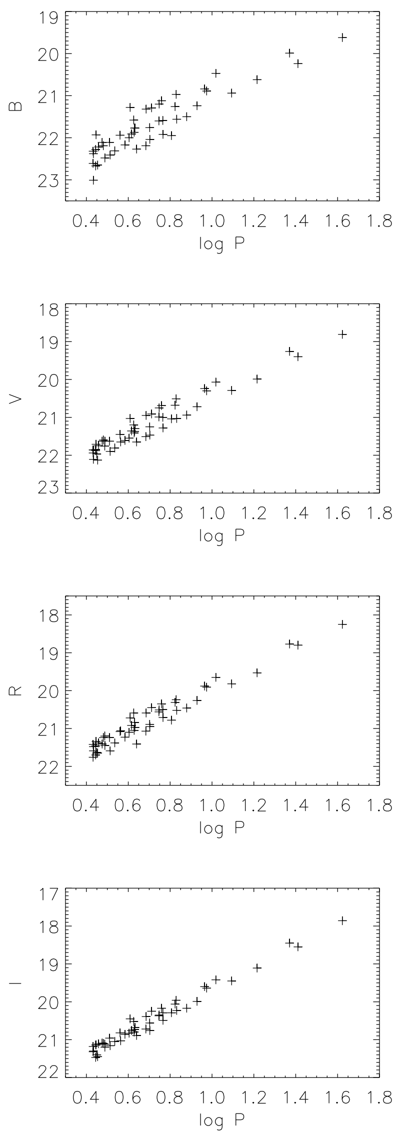

Fig. 1. BVRI P-L diagrams for Cepheids in IC 1613 (not corrected for reddening)

Moreover, owing to the better accuracy, we adopted the I-band photometry of OGLE, and used WFI I-band data when OGLE data were lacking.

3. PL diagrams

Freedman method is based on the fact that the light curve shape of Cepheids in the optical band depends on the filter in a way that, in a first approximation, can be represented with a multiplication by a factor (to take account of the different amplitude) and a small phase change. Practically, one could adopt the following average amplitude ratios: B:V:Wh:R:I = 1.00:0.67:0.56:0.44:0.34, and phase shifts: 0.03 (B,V), 0.05 (B,Wh), 0.07 (B,R) and 0.10 (B,I) to obtain a light curve in a band from that in another filter. The method is quite robust, in the sense that the resulting mean (intensity) values in the various bands are not much sensitive to changes in the ratios and shifts. For 48 of 52 Cepheids the template light curve was that of V-band, and for 4 Cepheids that of Wh-band (since no OGLE V-data were available). The PL diagrams show the expected main characteristics: the slope of the relation increases with the wavelength, while the dispersion decreases. The 6 WFI V-data points were merged with OGLE ones for 48 Cepheids, while for 4 Cepheids only the WFI data points were used. The OGLE I-band data were directly used for most stars. WFI I-data were used for stars with no OGLE data. The resulting relations are

$$B = -2.48\,(\pm.16)\,(\log P - 1.) + 20.99(\pm.06)$$
$$V = -2.70\,(\pm.10)\,(\log P - 1.) + 20.38(\pm.04)$$
$$R = -2.85\,(\pm.10)\,(\log P - 1.) + 19.94(\pm.04)$$
$$I = -2.94(\pm.07)\,(\log P - 1.) + 19.64(\pm.03)$$

The relations for the V and I bands are of course not very different from those of Udalski et al. (2001), and are similar within the errors to those of Cepheids of the Large Magellanic Cloud (Sandage et al. 2004).

The complete analysis and discussion of colors, magnitudes and reddening will be published elsewhere.

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