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ORIGINAL ARTICLE

Calibrating the Cepheid Period-Luminosity relation from the near-infrared surface brightness technique

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Abstract We have applied the near-infrared surface-brightness method to 111 Cepheids in the Milky Way and in the Large and the Small Magellanic Clouds determining distances and luminosities for the individual stars. We find that the K-band Period-Luminosity (PL-)relations for Milky Way and Large Magellanic Cloud Cepheids are almost identical, whereas the zero point of the Wesenheit relation depends significantly on metallicity, metal poor Cepheids being fainter.

We determine empirically the relation between the projection factor, p, and pulsational period, P, used for converting the observed radial velocities into the pulsational velocities necessary for applying the near-infrared surface-brightness method. We also determine the p-factor relation on a theoretical basis and find a significantly shallower slope than from our empirical determination, suggesting that there is still some physics related to the method which deserves further investigation.

Using the empirical p-factor relation we re-determine the Cepheid PL-relation in the K-band using all 111 Cepheids. We argue that this is the currently best PL-relation for distance determination being largely independent of both metallicity and reddening.

Keywords Cepheids · Baade-Wesselink analysis · Extragalactic distance scale

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1 Introduction

The Cepheid Period-Luminosity relation remains fundamental to the delineation of the extragalactic distance scale but the calibration of the relation itself and possible metallicity effects are still a matter of debate. Recently, Benedict et al. (2007) have succeeded in determining direct parallaxes to ten nearby Cepheids with individual precision better than about 10 %. Gaia holds the potential to measure direct parallaxes of hundreds of Cepheids and thus to define a Milky Way Period-Luminosity relation with unprecedented precision. However, to determine the effect of metallicity on the relation, which is crucial for the application to extragalactic Cepheids, a significant sample of stars spanning a significant range in abundances are necessary and these stars are not readily available in the Milky Way. We, Storm et al. (2011a, 2011b), have recently undertaken an investigation of Cepheids in both the Milky Way and the Magellanic Clouds to determine period-luminosity relations using the near-infrared surface brightness technique and to perform a direct differential comparison of identical samples of stars, analyzed in a consistent way to determine the effect of metallicity on the relations. As an added benefit we find a