A&A 550, A70 (2013)
DOI: 10.1051/0004-6361/201220446
© ESO 2013

Astronomy & Astrophysics

Baade-Wesselink distances to Galactic and Magellanic Cloud Cepheids and the effect of metallicity⋆

M. A. T. Groenewegen

Koninklijke Sterrenwacht van België, Ringlaan 3, 1180 Brussels, Belgium
e-mail: marting@oma.be

Received 26 September 2012 / Accepted 22 October 2012

ABSTRACT

Context. The metallicity dependence of the Cepheid period–luminosity (PL) relation is of importance in establishing the extragalactic distance scale.

Aims. The aim of this paper is to investigate the metallicity dependence of the PL relation in V and K, based on a sample of 128 Galactic, 36 Large Magellanic Cloud (LMC), and 6 Small Magellanic Cloud (SMC) Cepheids with individual Baade-Wesselink (BW) distances (some of the stars also have an *Hubble* Space Telescope (HST) based and HIPPARCOS parallax or are in clusters) and individually determined metallicities from high-resolution spectroscopy.

Methods. Literature values of the V-band, K-band, and radial velocity data were collected for the sample of Cepheids. Based on a $(V - K)$ surface–brightness relation and a projection factor, distances were derived from a BW analysis.

Results. The p-relation finally adopted is 1.50–0.24 log P. The slope of this relation is based on the condition that the distance to the LMC does not depend on period or $(V - K)$ colour and that the slope of the PL relation based on the BW distances agrees with that based on apparent magnitude. The zero point of the relation is tight to the Cepheids with HST and revised HIPPARCOS parallaxes as well as to Cepheids in clusters. The slope of the Galactic and LMC K-band relation formally agrees within the errors, and combining all Cepheids (including the SMC) results in a negligible metallicity dependence and a relation of $M_K = (-2.50 \pm 0.08) + (-3.06 \pm 0.06) \log P$. A similar conclusion is found for the reddening-free Wesenheit relation $(W(VK) = K - 0.13\ (V - K))$, with $M_{\rm WVK} = (-2.68 \pm 0.08) + (-3.12 \pm 0.06) \log P$. In the V-band the situation is more complex. The slope of the LMC and the Galactic PL relation differ at the 3σ level. Combining the sample nevertheless results in a metallicity term significant at the 2σ level: $M_{\rm V} = (-1.55 \pm 0.09) + (-2.33 \pm 0.07) \log P + (+0.23 \pm 0.11)$[Fe/H]. Taking only the Galactic Cepheids, the metallicity term is no longer significant, namely (+0.17 ± 0.25). Compared to the recent works by Storm et al. (2011a, A&A, 534, A94; 2011b, A&A, 534, A95), there is both agreement and disagreement. A similar dependence of the p-factor on period is found, but the zero point found here implies a shorter distance scale. The distance modulus (DM) to the LMC and SMC found here are 18.29 ± 0.02 and 18.73 ± 0.06 (statistical error on the mean), respectively. Systematic differences in reddening could have an effect of order +0.05 in DM. The details of the comparison of BW-based distances and Cepheids with HST and revised HIPPARCOS parallaxes also play a role. The method used by Storm et al. would lead to larger DM of 18.37 and 18.81 for the LMC and SMC, respectively. The LMC DM is shorter than the currently accepted value, which is in the range 18.42 to 18.55, and it is speculated that the p-factor may depend on metallicity. This is not predicted by theoretical investigations, but these same investigations do not predict a steep dependence on period either, indicating that additional theoretical work is warranted.

Key words. stars: distances – stars: variables: Cepheids

1. Introduction

Cepheids are considered an important standard candle because they are bright and thus the link between the distance scale in the nearby universe and that further out via those galaxies that contain both Cepheids and SNIa (e.g. Riess et al. 2009)

Distances to local Cepheids may be obtained in several ways, e.g. through main-sequence fitting for Cepheids in clusters (e.g. Feast 1999; Turner 2010) or via determination of the parallax. Benedict et al. (2007) published absolute trigonometric parallaxes for ten Galactic Cepheids using the Fine Guidance Sensor on board the *Hubble* Space Telescope (HST), and revised HIPPARCOS parallaxes have also become available (van Leeuwen et al. 2007).

In addition, distances to Cepheids can be obtained from the Baade-Wesselink (BW) method. This method relies on the availability of surface–brightness (SB) relations to link variations in colour to variations in angular diameters and an understanding of the projection (p-) factor, which links radial velocity to pulsational velocity variations.

A lot has been published on the subject over the past decade by the group of Storm/Gieren/Fouqué and coworkers (Storm et al. 2004a,b; Gieren et al. 2005; Fouqué et al. 2007), which culminated in the recent works by Storm et al. (2011a,b). In those two papers, the authors analysed 70 Galactic and 41 Magellanic Cloud (MC) Cepheids. They found that, (a) the p-factor depends quite steeply on period, confirming Gieren et al. (2005), based on the requirement that the distance to the (barycenter of the) Large Magellanic Cloud (LMC) should not depend on period; (b) the K-band period–luminosity (PL) relation is universal, $M_K = -3.30\,(\pm 0.06)\,(\log P - 1) - 5.65\,(\pm 0.02)$; (c) the K-band PL relation is insensitive to metallicity; and (d) a distance modulus to the barycenter of the LMC of 18.45 ± 0.04 for a p-factor relation 1.550–0.186 log P, where the zero point was calibrated on the Cepheids with HST parallaxes (Benedict et al. 2007).

Independently, Groenewegen (2007, hereafter G07) investigated the SB relation (finding excellent agreement with the relation by Kervella et al. 2004a) and the p-factor, based on six

⋆ Tables 1–6, 10, and Appendix A are available in electronic form at http://www.aanda.org

Cepheids with interferometrically measured angular-diameter variations and known distances. Groenewegen (2008, hereafter G08) presented BW distances to 68 Galactic Cepheids with individually determined metallicities from high-resolution spectroscopy.

The main aim of that particular work was to address the metallicity dependence of the PL relation, which remains a matter of debate. Observations seem to consistently indicate that metal-rich Cepheids are brighter, and various estimates have been given in the literature, −0.88 ± 0.16 mag/dex (*BRI* bands, Gould 1994), $-0.44^{+0.1}_{-0.2}$ mag/dex (*VR* bands, Sasselov et al. 1997), −0.24 ± 0.16 mag/dex (*VI* bands, Kochanek 1997), −0.14 ± 0.14 mag/dex (*VI* bands, Kennicutt et al. 1998), −0.21 ± 0.19 in *V*, −0.29 ± 0.19 in *W*, −0.23 ± 0.19 in *I*, −0.21 ± 0.19 mag/dex in *K* (Storm et al. 2004a,b), −0.29 ± 0.10 mag/dex (*BVI* bands, Macri et al. 2006). G08 found values of +0.27 ± 0.30 mag/dex (*V*-band) and −0.11 ± 0.24 mag/dex (*K*-band).

Since then, values have been reported of −0.29 ± 0.11 mag/dex ($W_{\rm VI}$, Scowcroft et al. 2009), and a very steep value of ∼−0.8± ∼ 0.2($W_{\rm VI}$, Shappee & Stanek 2011). Finally, Storm et al. (2011) quote slopes of −0.23 ± 0.10 mag/dex ($W_{\rm VI}$), +0.09 ± 0.10 mag/dex (*V*-band), and −0.10 ± 0.10 mag/dex (*K*-band).

With the exception of Groenewegen (2008), no individual abundance determinations of individual Cepheids are used in these studies. Instead, abundances of nearby HII regions or even a mean abundance of the entire galaxy are used. Even in the recent work by Storm et al. all Galactic, Small Magellanic Cloud (SMC) and LMC Cepheids were assigned a metallicity typical of that galaxy.

The present paper is an update of Groenewegen (2007, 2008) and takes into account the latest available data, in terms of interferometrically determined angular diameters, photometric and radial velocity data, and individually determined metallicities. In this paper, we revisit BW distances to Cepheids with metallicity determinations, increasing the sample to over 120 Galactic stars, adding 6 SMC and 42 LMC objects, and using updated *p*-factor and SB relations. Section 2 describes the selection of the photometric and radial velocity data. Section 3 outlines how the data are modelled. In Sect. 4, the surface–brightness relation is discussed. Section 5 describes how the binary Cepheids are treated, and new and updated orbital elements are presented. Section 6 describes the results regarding the period–luminosity (–metallicity) (PL(Z)) relation. Section 7 presents conclusions.

2. The sample

Table 1 lists the 128 Galactic classical Cepheids used in this study. This is a significant increase with respect to the 68 stars considered in G08. This sample represents essentially all Galactic Cepheids with accurate individually determined metallicities (mostly from Luck & Lambert 2011 and Luck et al. 2011) that have sufficient optical, *K*-band, and radial velocity data available for a BW analysis[1]. The single largest new dataset that made this increase in sample size possible is the recent publication of near-infrared light curves of 131 northern Cepheids by Monson & Pierce (2011).

Contrary to G08, 42 MC Cepheids are also considered here, and Table 2 lists that sample. The radial velocity data presented by Storm et al. (2011b) contribute significantly to the fact that a BW analysis is now feasible for a sizeable sample of MC Cepheids.

Tables 1 and 2 list the sources of the *V*-band, *K*-band, and radial velocity data, as well as data which were not considered in the BW analysis[2]. Sometimes a certain range in Julian date is excluded, mostly to exclude some of the older datasets, which are less accurate. This is also done because there is a clear change in pulsation period, and these cases are marked by $\dot{P}$.

Since 2008, additional radial velocity data has been obtained using the 1.2 m Euler telescope located at the La Silla observatory (see G08, for a description of the data taking and data reduction). The new radial velocity (RV) data are presented in Table 3.

Tables 4 and 5 list the published iron abundances for the Galactic Cepheids and for 15 MC Cepheids (only one of those, HV 837, is located in the SMC). Most Galactic [Fe/H] values come from Luck & Lambert (2011) and Luck et al. (2011), while the majority of MC Cepheid determinations are from Romaniello et al. (2008). To put all metallicities on the scale of Luck & Lambert (2011), differences were determined between the other references and them. Following the reference numbers in Table 4, the differences are 2 − 1 = −0.07 ± 0.09 (*N* = 184 objects in common), 3 − 1 = −0.11 ± 0.11 (*N* = 25), 4 − 1 = −0.18 ± 0.08 (*N* = 11), and 5 − 1 = −0.09 ± 0.07 (*N* = 47). The [Fe/H] values used in this paper are the published values corrected for these offsets.

For the five SMC Cepheids without metallicity determination the value in Storm et al. (2011b) is adopted: [Fe/H] = −0.68. For the four Cepheids in the LMC cluster NGC 1866 without a metallicity determination a value of −0.39 is adopted. This is the median of the values of the three Cepheids in the cluster that do have a metallicity determination (HV 12197, HV 12199, and We2; Molinaro et al. 2012) and is in agreement with the average metallicity of −0.43 determined by Mucciarelli et al. (2011). For the other LMC Cepheids without metallicity determination, the value used in Storm et al., −0.34 is used. This is very close to the median value of −0.36 of the 12 LMC Cepheids not in NGC 1866 listed in Table 5.

Reddening values with errors were preferentially taken from Fouqué et al. (2007, for 105 objects) and otherwise from van Leeuwen et al. (2007, for 16 objects, the value listed as ET in their Table A1), Andrievsky et al. (2002, four objects), Luck et al. (2011, one object), and Tammann et al. (2004, two objects). For the MC Cepheids, the values in Storm et al. (2011b) were adopted with an error in $E(B-V)$ of 0.005. The $E(B-V)$ values and errors are listed in Col. 2 of Table 10.

The following Galactic Cepheids are considered to be first overtone pulsators (e.g. Klagyivik & Szabados 2009): FF Aql, SZ Tau, SU Cas, QZ Nor, GH Lup, DT Cyg. When relations are plotted against period, their periods are "fundamentalised" following Alcock et al. (1995). None of the LMC and SMC Cepheids in the sample are believed to be overtone pulsators.

3. The model

The model is outlined in G07 but will be briefly repeated here. The *V*-, *K*- and RV data with error bars are fitted with a function of the form

$$F(t) = F_0 + \sum_{i=1}^{i=N} \left(A_i \sin\left(2\pi\, t\, {\rm e}^{{\rm i}f}\right) + B_{\rm i} \cos\left(2\pi\, t\, {\rm e}^{{\rm i}f}\right)\right), \tag{1}$$

[1] Some Cepheids have considered, but the datasets were deemed insufficient for an accurate BW analysis: BK Aur and GH Cyg (too poor radial velocity data), EV Sct and X Sct (too poor NIR data).

[2] When deriving the binary orbits, all radial velocity (RV) data were used (see Sect. 5).

where $P = e^{-f}$ is the period (in days). The period is determined from the fit to the available optical photometry as this dataset is usually the most extensive. The period is then fixed when fitting Eq. (1) to the K-band and RV data.

The determination of the parameters is done using the MRQMIN routine (following the Levenberg-Marquardt method) from Press et al. (1992), which minimises

$$\chi^2 = \sum_{i=1}^{i=n} (F_i - F(t_i))^2 / (\sigma_{F_i})^2, \quad (2)$$

with F_i the measurement at time t_i, which has an error bar σ_{F_i}. Also the reduced χ^2 is defined as

$$\chi^2_r = \frac{\chi^2}{(n-p)}, \quad (3)$$

and the quantity BIC as

$$\mathrm{BIC} = \chi^2 + (p+1)\ \ln(n), \quad (4)$$

where $p = 2N + 2$ is the number of free parameters ($p = 2N + 1$ when fitting the RV and K light curve). As the number N of harmonics to be fitted to the data is a priori not known, one could obtain ever better fits (lower χ^2) by increasing N. The Bayesian information criterion (Schwarz 1978) is a formalism that penalises this, and N (for the V, K and RV curve independently) is chosen such that BIC reaches a minimum. The number of harmonics used varies between 3 and 10 in the optical, 1 and 5 in the NIR, and 2 and 8 for the RV curves.

Given the analytical form of Eq. (1), the RV curve can be exactly integrated to obtain the variation in radius as a function of time (phase):

$$\Delta R(t, \delta\theta) = -p \int_{t_0}^{t+P\delta\theta} (v_R - \gamma)\, dt, \quad (5)$$

where γ is the systemic velocity, v_R the radial velocity, p the projection factor and $\delta\theta$ allows for a phase shift between the RV curve and the angular-diameter variations determined via the SB relation.

Then, the equation

$$\theta(t) = 9.3038\ \mathrm{mas} \left(\frac{R_0 + \Delta R(t, \delta\theta)}{d}\right) \quad (6)$$

is fitted with θ the angular diameter in mas, R_0 the stellar radius in solar radii and d the distance in pc.

Compared to G08, the fitting procedure was changed. In G08, the fitting was done implementing the linear bisector (using the code SIXLIN from Isobe et al. 1990) as used and preferred by e.g. Storm et al. (2004a,b), Barnes et al. (2005a,b), Gieren et al. (2005), and Storm et al. (2011a,b). The bisector is still the preferred method, but errors in both ΔR and θ are now taken into account using the bivariate correlated errors and intrinsic scatter (BCES) method (Akritas & Bershady 1996)[3]. The error in $\theta(t)$ includes the error in V and K magnitude and the error in $E(B-V)$, while the error in ΔR includes the error in the Fourier coefficients, see Eq. (1). An alternative method is also considered based on a non-linear least-squares fit with four parameters (p, d, R_0, and $\delta\theta$). When the distance is known (the Cepheids with HST parallaxes, see Sect. 4), one solves for p (R_0 and $\delta\theta$). In most cases (Sect. 6), one solves for d (R_0 and $\delta\theta$) for a given p. In G08, this method was already implemented in order to derive $\delta\theta$. Then the bisector method was used with this $\delta\theta$ in order to derive the distance. However, the value of $\delta\theta$ that best fits the data from the non-linear fit does not necessarily best fit the data using the bisector. In the present paper, the non-linear fit is used to derive $\delta\theta$ and its error, and the BCES method is used for 21 values of $\delta\theta$ within $\pm 4\sigma$ of its best-fit value to find the best-fitting distance. In some cases, a phase range around 0.85–0.95 is excluded from the fit (likely related to shocks in the stellar atmosphere close to minimum radius).

[3] http://www.astro.wisc.edu/~mab/archive/stats/stats.html

4. The *p*-factor and surface–brightness relation

One way of deriving the p-factor (and its dependence on period) is to use interferometrically determined angular diameters for a sample of stars with known distances, e.g. Mérand et al. (2005) and G07. The conclusion in G07 was that, statistically, there was no need to include a period dependence and that a constant value of $p = 1.27 \pm 0.05$ fitted the available data at that time, based on six stars.

The theoretical investigation by Nardetto et al. (2007) suggested that there is a difference between the p-factor to be used with wide-band interferometry (like in G07) and with RV data (when applying the SB technique as in G08 and the present study). For δ Cep, this difference is of the order of 0.06 (Nardetto et al. 2007), in the sense that in SB studies the p-factor is slightly larger and $p = 1.33$ was used in G08.

New interferometric angular-diameter determinations have become available since 2008, and the p-factor dependence on period is investigated first. Table 6 lists the stars with an independent distance estimate and/or interferometrically determined (limb-darkened) angular diameters. Columns 2 and 4 give the period and $E(B-V)$ value.

The distances come primarily from van Leeuwen et al. (2007), who took the weighted average of the HST determined parallax (Benedict et al. 2007) and the revised HIPPARCOS parallax given in the same paper (the exception was Y Sgr for which the HST value was adopted). The Lutz-Kelker (LK) correction (Lutz & Kelker 1973) in Col. 4 is taken from van Leeuwen et al. (2007) and included in determining the most probable distance. For δ Cep and ζ Gem, the recent distance determinations to the host clusters (Majaess et al. 2012a,b) were also considered in the distances finally adopted, which are listed in Col. 6. Column 7 lists the references to the interferometric observations.

Columns 8 and 9 list the derived p-factor and mean radius. The first error bar is the error in the fit, while the second is the error due to the error in the distance.

The analysis of these eight stars allows one to derive a period-radius (PR) relation, which is shown in Fig. 1. A linear weighted least-squares fit results in

$$\log R = (0.696 \pm 0.033) \log P + (1.115 \pm 0.030), \sigma = 0.022, \quad (7)$$

where the two error bars for R listed in Table 6 have been added quadratically. Figure 1 shows the recent PR relation from Molinaro et al. (2011), $\log R = (0.75 \pm 0.03) \log P + (1.10 \pm 0.03)$, for comparison.

Using the PR relation of Eq. (7), the radii of η Aql and Y Oph were estimated with their error bar. For this radius, the distance and p-factor were determined with their error bars (the internal error is listed first, and then the error due to the uncertainty in R).

Figure 2 plots the relation between the derived p-factor and $\log P$ for the seven stars with an error (the quoted error bars on p were added quadrature) less than 0.4. A weighted least-squares

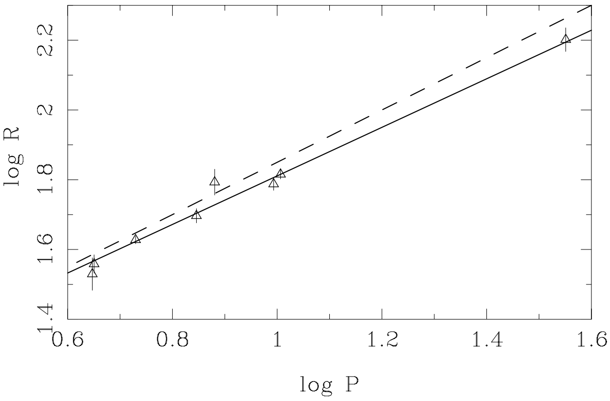

Fig. 1. The PR relation derived in the present paper (the solid line, which is the fit to the data points with error bars) compared to the PR relation of Molinaro et al. (2011), represented by the dashed line.

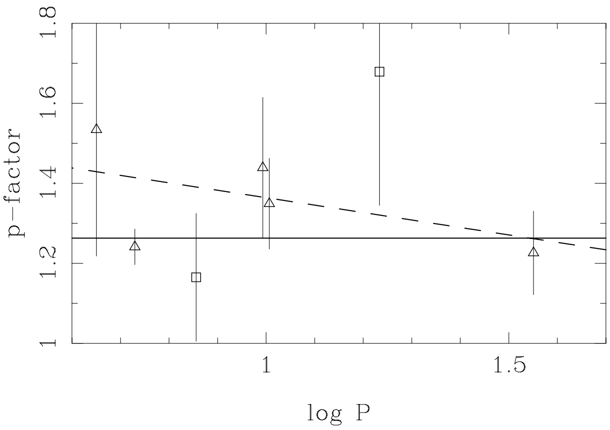

Fig. 2. The *p*-factor plotted versus log period for the seven stars that have an error in *p* smaller than 0.4. The open squares indicate the two stars for which the radius was fixed from the PR relation. Also plotted is a line indicating the best constant value of $p = 1.264$, while the dashed lines represent the *p*-factor relation proposed by Storm et al. (2011a), $p = 1.550 - 0.186 \log P$.

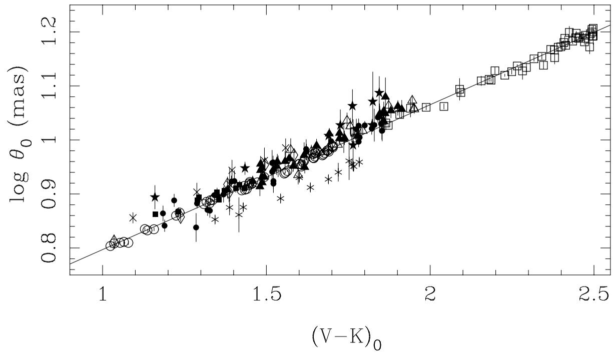

Fig. 3. Log θ_0 versus de-reddened $(V-K)$ colour for Cepheids. Different symbols indicate the different stars. (δ Cep = ○, *l* Car = □, ζ Gem = △, η Aql = •, β Dor = ▲, FF Aql = ■, T Vul = ◇, W Sgr = ★, X Sgr = x, Y Oph= ∗).

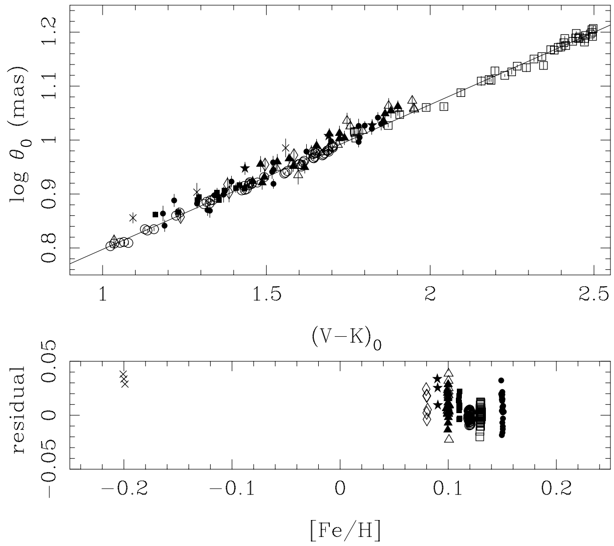

Fig. 4. Log θ_0 versus $(V-K)_0$ colour for Cepheids, excluding Y Oph and with errors on the angular diameters <0.065″. The *bottom panel* shows the residuals plotted against [Fe/H]. Symbols as Fig. 3.

fit is made to find that there is no evidence from this data alone of a dependence on period: $p = (1.24 \pm 0.12) + (+0.03 \pm 0.13) \log P$, nor on period and metallicity: $p = (1.75 \pm 0.40) + (+0.06 \pm 0.13) \log P + (-4.5 \pm 3.4)$ [Fe/H]. The best-fitting constant value is $p = 1.264 \pm 0.036$, similar to what was found in G07.

Independently of the derivation of the PR relation or the *p*-factor, the available interferometric, optical, and infrared data can be used to calibrate the SB relation for Cepheids, very much in line with Kervella et al. (2004a) and G07. An SB relation can be defined as follows (see van Belle 1999):

$$\theta_0 = \theta \times 10^{(m_1/5)}, \tag{8}$$

where θ is the LD angular diameter (in mas) and m_1 a de-reddened magnitude (for example, V). The logarithm of this quantity (the zero magnitude angular diameter) is plotted against a de-reddened colour (for example, $(V-K)_0$),

$$\log \theta_0 = a(m_2 - m_3) + b. \tag{9}$$

The aim is to determine the coefficients a and b.

Table 7 list the various results. Figure 3 shows the results, including all objects and where the error in the angular-diameter determination is less than 0.2″ to exclude some extreme outliers. Different stars are marked by different symbols as given in the caption. The relation is extremely well defined but as noted in G07 Y Oph (the ∗ -symbol) clearly lies below the relation, and there are still some data points with large error bars (e.g. W Sgr, indicated by the ★ symbol). The determination of the SB relation is affected by reddening, and Y Oph has by far the largest reddening of the stars under consideration here. A reddening of $E(B-V) \sim 1$ would bring it onto the relation.

Figure 4 shows the results ignoring Y Oph and selecting only angular diameters determined with an error <0.065″. More complicated relationships than Eq. (9) were also investigated, in particular adding a quadratic term in $(V-K)_0^2$, a linear term on period, and a linear term in [Fe/H]. The quadratic term in colour and a linear term on period do not result in coefficients that are significant. However, a linear term on metallicity (i.e. $\log \theta_0 = a\,(V-K)_0 + b + c$ [Fe/H] appears significant, as illustrated in the bottom panel of Fig. 4.

This result does not depend on X Sgr at [Fe/H]= −0.20. Excluding it still results in a coefficient determined at the 3σ level. Uncertainties in reddening could introduce a metallicity dependence. When FF Aql is ignored as well, thereby restricting the sample to the stars with $E(B-V)$ less than 0.15, and only angular diameters determined with an error <0.05″ are

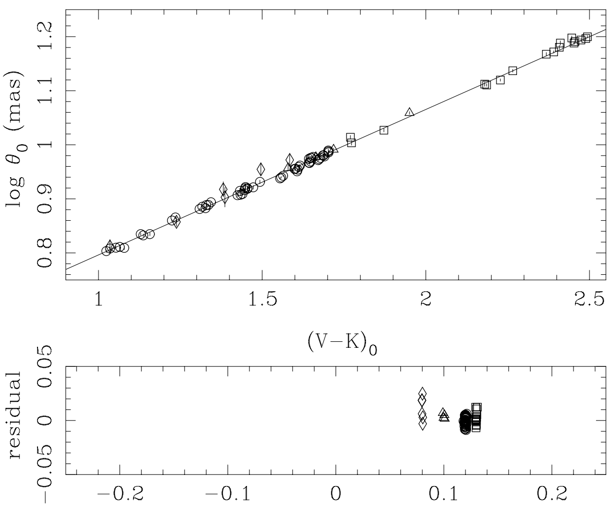

Fig. 5. Log θ_0 versus $(V-K)_0$ colour for Cepheids, excluding Y Oph, X Sgr and FF Aql and with errors on the angular diameters <0.05″. The bottom panel shows the residuals plotted against [Fe/H]. Symbols as Fig. 3.

selected, the coefficient is determined at the the 2σ level (see Fig. 5).

Excluding X Sgr, the spread in [Fe/H] over the sample is small and comparable to the measurement error. To test a possible metallicity dependence of the SB relation, a Monte Carlo simulation was performed, assuming a Gaussian error of 0.05 dex in [Fe/H] and Gaussian errors in $E(B-V)$, V, and K. The resulting SB relations are reported in Cols. 8–12 of Table 7. The dependence on metallicity is weaker now, at the 1σ level or less.

The SB relation adopted in this paper is based on the second solution from Table 7, $\log\theta_0 = 0.2674\,(V-K)_0 + 0.5327$. Table 7 also includes other SB relations, including the one by Kervella et al. (2004a), which has also been used by Storm et al. (2011a,b)[4]. The agreement is excellent.

Figure 6 compares the angular diameters determined from interferometry with those calculated from photometry and the SB relation for δ Cep and l Car, the two Cepheids with the best and most extensive set of interferometrically determined angular diameters. The agreement is very good and illustrates the power of SB relations.

5. Binary Cepheids

A number of stars in the sample are known or suspected spectroscopic binaries. In order to apply the SB technique outlined in the previous section, the RV data have to be corrected for the binary motion. The procedure is outlined in G08. For a number of stars[5], the elements of G08 were used. For FF Aql, V350 Sgr, V496 Aql, and VZ Cyg, new RV data allowed for an improved orbit compared to G08. For X Sgr, the new RV data do not support the solution presented in G08. Although a period analysis continues to show a peak at 572 days, the binary solution is not satisfactory. For X Sgr no binary orbit is assumed here. The

[4] Note that in their 2011a paper near their Eq. (2), it is stated that the SB relation used is from Fouqué & Gieren (1997) but this is not the case. The 2011b paper has the correct reference.

[5] S Mus, S Nor, S Sge, SU Cas, SU Cyg, T Mon, U Vul, W Sgr, XX Cen, Z Lac.

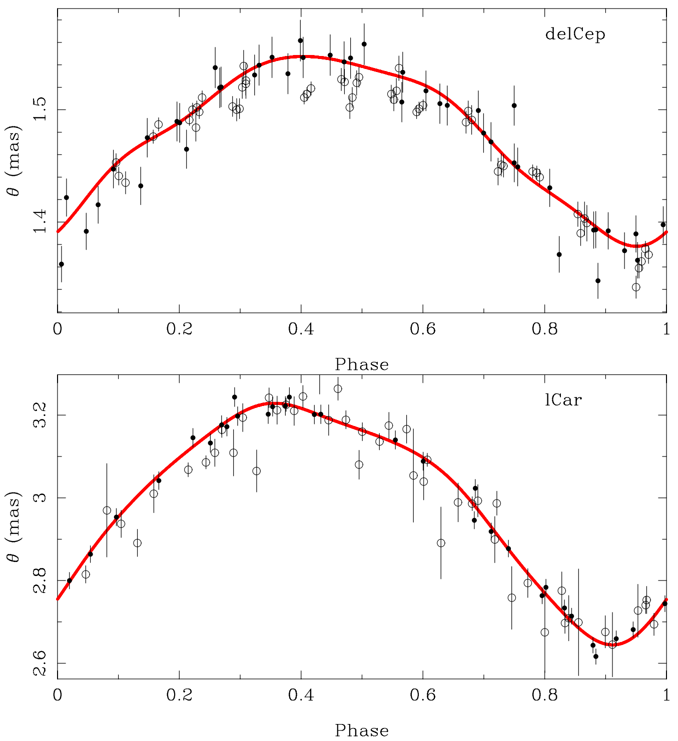

Fig. 6. Comparison between the angular diameters determined from the SB relation (filled circles), and from interferometry (open circles) from δ Cep and l Car.

orbital elements (three updated and five new orbits) are listed in Table 8.

For V496 Aql the period changed considerable. A period analysis showed that the period preferred in G08 (1331 days) only has the third highest peak in the current Fourier spectrum and that 1065 days clearly shows the better fit. For V350 Sgr the orbit is updated and compares well to the recent orbit by Evans et al. (2011).

For the known spectroscopic binaries, the derived orbital parameters are close to literature values, cf. RX Cam (Imbert 1996), DL Cas (Gieren et al. 1994), MW Cyg (Imbert 1996; and Rastorgouev et al. 1997. The eccentricity derived here is in between the two values quoted), AW Per (Evans et al. 2000), and U Aql (Welch et al. 1987a,b). For Y Oph, the very non-eccentric orbit proposed by Abt & Levy (1978) is not confirmed.

6. Results

6.1. The period dependence of the p-factor

In their most recent work, Storm et al. (2011a) proposed a p-factor of $(1.55 \pm 0.04) - (0.186 \pm 0.06) \log P$, confirming their earlier result of $p = (1.58 \pm 0.02) - (0.15 \pm 0.05) \log P$ by Gieren et al. (2005). The slope is derived from the requirement that the distance to the barycenter of the LMC should not depend on period.

Independently, for the Galactic Cepheids with HST parallaxes, one can determine the p-factor which makes the BW distance equal to the HST-based distance. Storm et al. (2011a) find $p = (1.65 \pm 0.07) - (0.28 \pm 0.08) \log P$. The p-factors derived in this way are reported in Col. 10 of Table 6 and a fit to the six stars with and error <0.15 gives $p = (1.33 \pm 0.16) - (0.07 \pm 0.16) \log P$. The best-fit constant value is $p = 1.27 \pm 0.03$. In a similar fashion, Ngeow et al. (2012) considered not only stars with an

Table 7. Coefficients of the SB relation.

Condition	N	b	a	b	a	c	b	a	b	a	c
$\sigma_\theta < 0.2$	226	0.5322	0.2672	0.5435	0.2689	–0.119	0.5335	0.2663	0.5382	0.2667	–0.056
		0.0032	0.0019	0.0039	0.0019	0.022	0.0029	0.0017	0.0078	0.0039	0.048
$\sigma_\theta < 0.065$	170	0.5327	0.2674	0.5435	0.2688	–0.111	0.5338	0.2667	0.5384	0.2664	–0.048
Y Oph excluded		0.0033	0.0020	0.0043	0.0020	0.028	0.0028	0.0016	0.0073	0.0032	0.043
$\sigma_\theta < 0.065$	167	0.5317	0.2679	0.5479	0.2691	–0.151	0.5329	0.2672	0.5370	0.2662	–0.032
Y Oph & X Sgr excluded		0.0033	0.0020	0.0070	0.0020	0.057	0.0029	0.0016	0.0099	0.0035	0.069
$\sigma_\theta < 0.03$	79	0.5251	0.2705	0.5477	0.2723	–0.212	0.5263	0.2697	0.5319	0.2679	–0.030
Y Oph, X Sgr, & FF Aql excluded		0.0042	0.0026	0.0133	0.0028	0.119	0.0038	0.0020	0.0120	0.0030	0.096
Fouqué & Gieren (1997)		0.547	0.262								
		0.006	0.004								
Kervella et al. (2004a)		0.5354	0.2672								
		0.0012	0.0016								
G07		0.5235	0.2752								
		0.0092	0.0045								

Notes. Column 1 gives the conditions applied or the reference to the literature; Col. 2 the number of data points, and Cols. 3–4 and 5–7 the coefficients of the SB relation. Columns 8–12 repeat these numbers based on the Monte Carlo simulation. The second line gives the errors in the coefficients. The adopted coefficients are indicated in boldface.

Table 8. Derived orbital parameters of binary Cepheids.

Name	γ (km s^{-1})	K (km s^{-1})	e	ω (°)	T_0 (JD – 2 400 000)	Binary period (d)
FF Aql	–15.71 ± 0.07	4.98 ± 0.06	$0.011^{+0.033}_{-0.008}$	362 ± 103	45 609 ± 415	1432.7 ± 0.9
V496 Aql	4.51 ± 0.14	3.63 ± 0.18	0	0	45 480 ± 17	1066.2 ± 1.9
V350 Sgr	11.43 ± 0.05	10.50 ± 0.07	$0.351^{+0.007}_{-0.007}$	283 ± 1	52 015 ± 4	1468.9 ± 0.9
VZ Cyg	–16.96 ± 0.10	3.02 ± 0.16	0	0	44 811 ± 36	2183 ± 10
RX Cam	–37.54 ± 0.06	14.27 ± 0.11	$0.459^{+0.007}_{-0.006}$	78.4 ± 1.0	45 931.3 ± 1.8	1113.8 ± 0.5
DL Cas	–36.23 ± 0.06	16.43 ± 0.11	$0.350^{+0.006}_{-0.006}$	27.3 ± 1.0	47 161.6 ± 1.5	684.27 ± 0.16
MW Cyg	–13.37 ± 0.12	6.43 ± 0.19	$0.140^{+0.030}_{-0.025}$	78 ± 13	48 862 ± 15	439.61 ± 0.18
AW Per	6.60 ± 0.35	12.06 ± 0.32	$0.499^{+0.032}_{-0.030}$	254 ± 3	38 721 ± 178	14293.70 ± 283
U Aql	1.14 ± 0.14	7.75 ± 0.22	$0.134^{+0.025}_{-0.021}$	163 ± 9.5	42 634 ± 49	1853.6 ± 3.0

Notes. Quantities without error bar have been fixed.

HST parallax (from van Leeuwen et al. 2007) but also Cepheids in clusters (from Turner 2010), determining that p-factor that makes the BW distance (which they took from Storm et al.) equal to the independently known distance. They find $p = (1.462 \pm 0.087) + (-0.172 \pm 0.086) \log P$, or, excluding the outlier FF Aql, $p = (1.447 \pm 0.070) + (-0.159 \pm 0.070) \log P$.

Figure 7 shows the distance to the LMC Cepheids versus $\log P$ for $p = 1.33$. As the distance is proportional to the p-factor and since the dependence on period is assumed to be linear in $\log P$, the slope in this plot indicates what the $p - \log P$ dependence should be to have no dependence of distance on period. Depending on whether the slope is derived from the bisector (the dashed line), or a weighted least-squares fit (the solid line), the result is -0.28 ± 0.05 or -0.21 ± 0.04, respectively.

One can also make the consideration that the distance should be independent of (mean) $(V - K)$ colour. Figure 7 shows the result for $p = 1.33$. As period and colour are related, this is not independent of the earlier estimate. Trying various coefficients, it is found that a slope of -0.21 ± 0.05 or -0.24 ± 0.05 will give no dependence on colour, for the bisector and weighted least-squares fit, respectively.

The BW method is primarily of interest because it gives absolute distances. For the Cepheids in the LMC, one can also expect and demand that the *slope* of the PL relation in the V- and K-band is independent of whether it is derived from M_V and M_K taking the BW distances or from the purely observed mean V_0 and K_0 magnitudes.

The observed PL relations are listed in Table 9 and shown in Fig. 8. Apart from V and K, the reddening free combination of these colours is also included, $W(VK) = K - 0.13\ (V - K)$ (see Inno et al. 2012). Three solutions are listed, depending on whether the LMC Cepheids are put at the barycenter or not. In the former case, one corrects for the tilt and orientation of the LMC disk. The model by van der Marel & Cioni (2001) was used (as Storm et al. 2011b did). It is based mainly on AGB stars located between 2.5 and 6.7° from the LMC centre. An alternative model used is that by Nikolaev et al. (2004), which is based on 2100 Cepheids within 4° from the centre. The slope and zero point of the observed PL relations are very similar, independent of the type of correction. The smallest dispersion in the K-band is actually achieved when applying *no* correction. The solution was calculated using a bisector and a weighted least-squares fit and is largely in agreement. The slopes derived here from the observations are in excellent agreement with literature values, some of which are also listed in Table 9.

As the absolute magnitudes depend on the distance, which in turn depends on the p-factor, changing the slope in the $p - \log P$ relation will change the slope of the PL relation. Demanding that the two are equal, it is found that the slope is -0.25 ± 0.05 and -0.25 ± 0.05, in the $K-$ and $V-$band, respectively. Taking the

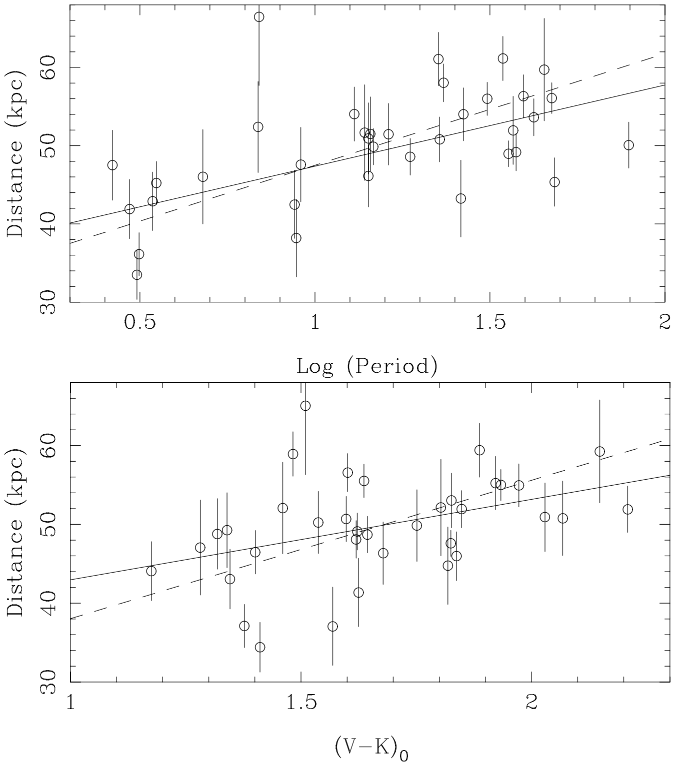

Fig. 7. Distance to the barycenter of the LMC against log P and against mean $(V-K)$ colour for a constant p-factor of 1.33. The dashed line indicates the bisector fit, the solid line the least-squares solution.

average of these six determinations, the finally adopted relation is $p = p_o - 0.24 \log P$ (with an estimated error of 0.03). The dependence of distance on $\log P$ and $(V-K)$ colour for the LMC Cepheids is shown in Fig. 9.

6.2. The zero point of the $p - \log P$ relation

As in Storm et al. (2011a) the zero point of the $p - \log P$ is based on stars that have an independent distance, namely those with a parallax (the ten stars listed in Table 6) and the Cepheids that are in clusters. For the latter, Storm et al. (2011a,b) used the associations and distances in Turner (2010). However, this list is not complete (cf. Tammann et al. 2003), and some results have become available since 2010. A discussion of the distances adopted for Cepheids in clusters in the present sample is presented in Appendix A.

The relation finally adopted is $p = 1.50 - 0.24 \log P$. For this relation, the weighted mean of the ratio of reference distance to BW distance (see later) is 1.000 ± 0.026 for eight stars which have a parallax (the two outliers that deviate by more than 3.4σ and that are removed are W Sgr with a ratio of 2.20 ± 0.36, and FF Aql with 0.58 ± 0.11), and 0.999 ± 0.014 for the 18 stars in clusters. In the latter case, the three outliers that deviate by more than 4.5σ and that are removed are SU Cyg with a ratio of 0.76 ± 0.05, VY Car with 1.57 ± 0.11, and X Cyg with 1.23 ± 0.04, while the recent determinations for δ Cep and ζ Gem were already considered when deriving the best distances for the stars with parallaxes (see Table 6).

In comparison, Storm et al. (2011a) base their zero point solely on nine stars with HST parallax (W Sgr is excluded as well, but its BW distance for FF Aql agrees with the HST-based one). An aposteriori comparison to the Cepheids in clusters (with the distances from Turner 2010) using 16 stars in common with their Galactic Cepheid sample (of which SU Cas is excluded, as the result from Majaess et al. (2012c) was not available to them) shows an unweighted mean difference of 0.12 ± 0.06 in distance modulus.

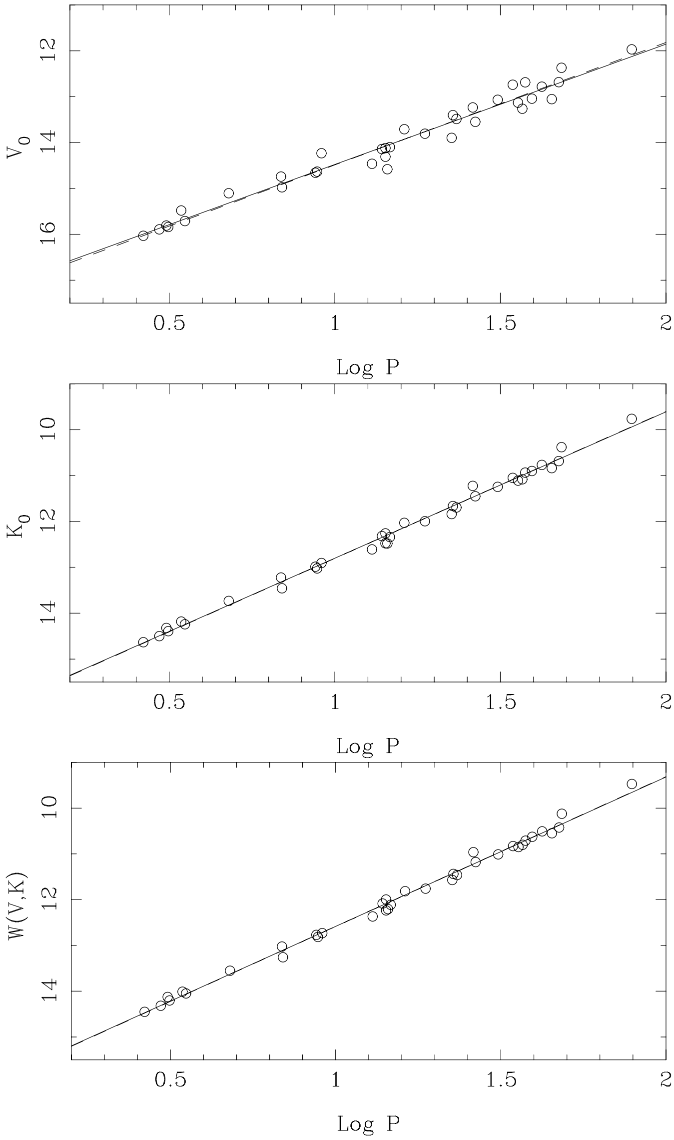

Fig. 8. Observed V-band (*upper panel*), K-band (*middle*) and $W(VK)$ (*bottom*) PL relations for the LMC Cepheids. The dashed line indicates the bisector fit, the solid line the least-squares solution (indistinguishable except in the *upper panel*).

Table 10 lists the distances, radii, and absolute magnitudes obtained for the Galactic, LMC, and SMC Cepheids. The table also lists the adopted $E(B-V)$ and error bar, the derived period, and the p-factor following $p = 1.50 - 0.24 \log P$ adopted in the present paper. The distances, radii, and errors scale directly with p. The error in the period is a few units in the last decimal place. For the derived quantities two error bars are quoted. For the distance and radius, the first error bar listed is the error in the fit, and for the absolute magnitudes the error is due to the error in distance and $E(B-V)$. The second error quoted is based on a Monte Carlo simulation, where (1) new datasets are generated based on the error bar in each individual V, K, and RV measurement, (2) the analysis takes into account an $E(B-V)$ value randomly drawn from a Gaussian distribution based on the listed

Table 9. Observed, using a bisector and weighted least-squares fit, and literature PL relations in the LMC.

Relation	Bisector	wLSQ	Remarks
Observed *K*-band	16.01 ± 0.05	15.99 ± 0.04	Correction van der Marel & Cioni (2001)
	–3.20 ± 0.04	–3.19 ± 0.04	
Observed *K*-band	16.03 ± 0.05	16.02 ± 0.04	Correction Nikolaev et al. (2004)
	–3.22 ± 0.04	–3.21 ± 0.04	
Observed *K*-band	16.06 ± 0.04	16.05 ± 0.03	No correction
	–3.25 ± 0.03	–3.24 ± 0.03	
Literature *K*-band		15.996 ± 0.010	Ngeow et al. (2009)
		–3.194 ± 0.015	
Literature *K*-band		16.070 ± 0.017	Ripepi et al. (2012)
		–3.295 ± 0.018	
Observed *V*-band	17.15 ± 0.08	17.09 ± 0.07	Correction van der Marel & Cioni (2001)
	–2.67 ± 0.07	–2.62 ± 0.07	
Observed *V*-band	17.18 ± 0.07	17.13 ± 0.07	Correction Nikolaev et al. (2004)
	–2.69 ± 0.06	–2.65 ± 0.06	
Observed *V*-band	17.21 ± 0.07	17.16 ± 0.07	No correction
	–2.72 ± 0.06	–2.68 ± 0.06	
Literature *V*-band		17.115 ± 0.015	Ngeow et al. (2009)
		–2.769 ± 0.023	
Literature *V*-band		–1.304 ± 0.065	Turner et al. (2010)
		–2.786 ± 0.075	
Observed *W*(*VK*)	15.86 ± 0.05	15.85 ± 0.04	Correction van der Marel & Cioni (2001)
	–3.27 ± 0.04	–3.26 ± 0.04	
Observed *W*(*VK*)	15.88 ± 0.04	15.87 ± 0.04	Correction Nikolaev et al. (2004)
	–3.30 ± 0.04	–3.29 ± 0.04	
Observed *W*(*VK*)	15.91 ± 0.03	15.91 ± 0.03	No correction
	–3.32 ± 0.03	-3.32 ± 0.03	
Literature *W*(*VK*)		15.901 ± 0.005	Inno et al. (2012)
		–3.326 ± 0.008	
Literature *W*(*VK*)		15.870 ± 0.013	Ripepi et al. (2012)
		–3.325 ± 0.014	

Notes. The zero point is listed in the first line, the slope in the second line.

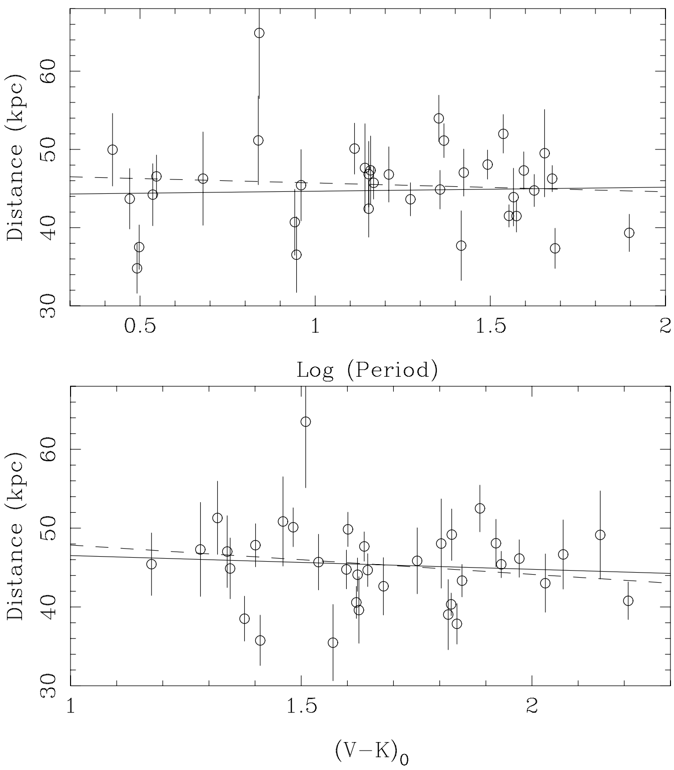

Fig. 9. Distance to the barycenter of the LMC against log *P* and against mean $(V-K)$ colour for a *p*-factor of 1.50−0.24 log *P*. The dashed line indicates the bisector fit, the solid line the least-squares solution.

mean value and 1σ error bar, (3) a random error in the *p*-factor of 0.02 units, and (4) a variation in the number of harmonics used to describe the optical, infrared, and RV curves. The second error quoted is the 1σ dispersion in the derived quantities.

Figure 10 illustrates the fit to the *V*, *K*, and RV curve for AQ Pup, while Fig. 11 shows the variation of the angular diameter against phase and the change in angular diameter derived from the SB relation against the change in radius from integration of the RV curve from which the distance is derived (see Eq. (5)). Figures similar to Figs. 10 and 11 for all stars in the sample are available from the author.

6.3. PL(Z) relations

Table 11 presents PL and PLZ relations of the form $M = \alpha \log P + \beta + \gamma$ [Fe/H] in the *V*, *W*(*VK*), and *K*-band. The results are given for the SMC, LMC, Galaxy, and for all Cepheids. Because of the small numbers of SMC Cepheids, the results for that galaxy are not reliable and are given for completeness only. For the Galactic Cepheids only and for the complete sample, a few clear outliers are removed (deviating by more than 0.8 mag from the PL relation).

Figures 12 and 13 show the PL relation in the *V*-band and *K*-band for the complete sample; in the bottom panel, the residual plotted against metallicity is shown. The first and second error bar quoted for the magnitudes in Table 10 have been added in quadrature.

The metallicity dependence was determined in two ways: 1) by first fitting a linear PL relation and fitting the residual with

Table 11. PL(Z) relations of the form $M = \alpha + \beta \log P + \gamma$ [Fe/H] + $\delta \log P$ [Fe/H], in the V, $W(VK)$, and K-band and for different galaxies.

Band	Galaxy	N	α	β	γ	δ
K	ALL	162	–2.50 ± 0.08	–3.06 ± 0.06	–	
K	GAL	121	–2.55 ± 0.09	–3.03 ± 0.08	–	
K	LMC	36	–2.26 ± 0.17	–3.21 ± 0.13	–	
K	SMC	6	–0.36 ± 0.98	–4.56 ± 0.78	–	
K	ALL	162	–2.49 ± 0.08	–3.07 ± 0.07	–0.05 ± 0.10	
K	GAL	121	–2.56 ± 0.09	–3.03 ± 0.08	0.07 ± 0.20	
K	LMC	36	–2.27 ± 0.18	–3.22 ± 0.13	0.19 ± 0.37	
K	SMC	6	–0.66 ± 0.99	–4.23 ± 0.81	–1.31 ± 0.86	
K	ALL	162	–2.47 ± 0.08	–3.08 ± 0.07	–0.59 ± 0.42	0.42 ± 0.31
V	ALL	160	–1.48 ± 0.08	–2.40 ± 0.07	–	
V	GAL	119	–1.68 ± 0.10	–2.21 ± 0.09	–	
V	LMC	36	–1.10 ± 0.17	–2.69 ± 0.12	–	
V	SMC	6	0.73 ± 0.93	–4.03 ± 0.74	–	
V	ALL	160	–1.55 ± 0.09	–2.33 ± 0.07	0.23 ± 0.11	
V	GAL	121	–1.69 ± 0.10	–2.21 ± 0.09	0.17 ± 0.25	
V	LMC	36	–1.09 ± 0.17	–2.68 ± 0.12	–0.14 ± 0.35	
V	SMC	6	0.48 ± 0.95	–3.74 ± 0.77	–1.19 ± 0.82	
V	ALL	160	–1.54 ± 0.09	–2.34 ± 0.08	–0.04 ± 0.46	0.21 ± 0.34
WVK	ALL	158	–2.68 ± 0.08	–3.12 ± 0.06	–	
WVK	GAL	120	–2.69 ± 0.09	–3.12 ± 0.08	–	
WVK	LMC	36	–2.41 ± 0.18	–3.27 ± 0.13	–	
WVK	SMC	6	–0.51 ± 0.98	–4.63 ± 0.78	–	
WVK	ALL	158	–2.69 ± 0.08	–3.11 ± 0.07	0.04 ± 0.10	
WVK	GAL	120	–2.72 ± 0.09	–3.13 ± 0.08	0.34 ± 0.20	
WVK	LMC	36	–2.42 ± 0.18	–3.29 ± 0.13	+0.23 ± 0.37	
WVK	SMC	6	–0.81 ± 0.99	–4.29 ± 0.81	–1.34 ± 0.85	
WVK	ALL	158	–2.70 ± 0.09	–3.11 ± 0.07	+0.17 ± 0.44	–0.10 ± 0.33

a linear relation against [Fe/H] (as shown in Figs. 12 and 13 by the solid line, done mainly for easy visualisation); and 2) by making a linear fit in the two variables $\log P$ and [Fe/H], as listed in Table 11 and shown in Figs. 12 and 13 by the dashed line.

The slopes of the LMC (-3.21 ± 0.13) and Galactic (-3.03 ± 0.08) PL relation in the K-band are formally consistent at the 1σ level; in the V-band they are consistent only at the 3σ level (-2.69 ± 0.12) for the LMC, (-2.21 ± 0.09) for the Galaxy). The better agreement in K and lesser agreement in V between the two galaxies is in line with theoretically predicted relations (Bono et al. 2010), which give slopes at $Z = 0.004$, 0.008, 0.02 in the K-band of -3.19 ± 0.09, -3.28 ± 0.09, and -3.22 ± 0.15, respectively, (and δslope/$\delta \log Z = 0.08 \pm 0.07$ over all metallicities they considered), and in the V-band of -2.87 ± 0.09, -2.80 ± 0.15, and -2.51 ± 0.24, respectively (and δslope/$\delta \log Z = 0.67 \pm 0.09$). The slope found for the Galactic Cepheids in the V-band (-2.21 ± 0.09) agrees at the 1.5σ level with the value of (-2.43 ± 0.12) in Benedict et al. (2007) based on the ten stars with HST parallaxes. In the K-band, the slope (-3.03 ± 0.08) agrees at the 2σ level with the (-3.32 ± 0.12) found by Benedict et al. The slopes found for the LMC Cepheids in the V-band (-2.69 ± 0.12) and K-band (-3.21 ± 0.13) are in excellent agreement with various determinations in the literature, see Sect. 6.1 and Table 9.

The metallicity dependence quoted in G08 based on 68 Galactic Cepheids were $\gamma = (+0.27 \pm 0.30)$ mag/dex (V-band) and (-0.11 ± 0.24) (K-band). Now, values of ($+0.17 \pm 0.25$) and ($+0.07 \pm 0.20$) from 121 Galactic Cepheids and ($+0.23 \pm 0.11$) and (-0.05 ± 0.10) mag/dex from the complete sample are derived. Compared to G08, the larger sample of Galactic Cepheids has reduced the error bar, but the main reduction in error bar has come from adding the MC Cepheids. The outcome is that the iron dependence of the PL relation in the K-band is not significant and only marginally significant (2σ) in the V band. A fit were the *slope* of the PL relation is also allowed to vary linearly with metallicity is also included in Table 11 but the error bars in the coefficients are large and the result is not significant.

6.4. The PR relation

Figure 14 shows the PR relation for all Galactic and MC Cepheids. The best fit is

$$\log R = (0.651 \pm 0.012) \log P + (1.136 \pm 0.014), \sigma = 0.055, \quad (10)$$

where 8 outliers (deviating by 0.17 dex, or about 3σ) have been removed[6].

This result does depend on the adopted p-factor relation. For a constant $p = 1.33$, for example, the relation would become $\log R = 0.737 \log P + 1.074$. This is in agreement with Molinari et al. (2011), who find $\log R = (0.75 \pm 0.03) \log P + (1.10 \pm 0.03)$ for a constant $p = 1.27$. A negative dependence of the p-factor on period leads to a shallower slope. The PR relation in Eq. (7) based on stars with known distance has a slope of 0.696 ± 0.033. This is in agreement with the present one, which depends on the p-factor. The slopes in the PR relation that are found in the present work are shallower than often quoted in the literature (see Molinari et al. (Molinari2011), and Turner et al. (2010) for recent compilations), but these also depend on the p-factor. For example, Gieren et al. (1998) find $\log R = (0.750 \pm 0.024) \log P + (1.075 \pm 0.007)$ for $p = 1.39 - 0.03 \log P$, while Turner & Burke (2002) find $\log R = (0.750 \pm 0.006) \log P + (1.071 \pm 0.006)$ for $p = 1.31$.

Theory predicts slopes shallower than this and more in agreement with the slopes found in the present paper. Recent models by Petroni et al. (2003) lead to $\log R = (0.676 \pm 0.006)$

[6] These are AN Aur, CR Ser, DT Cyg, V495 Cyg, VX Per, VY Cyg, W Sgr, and HV 1335.

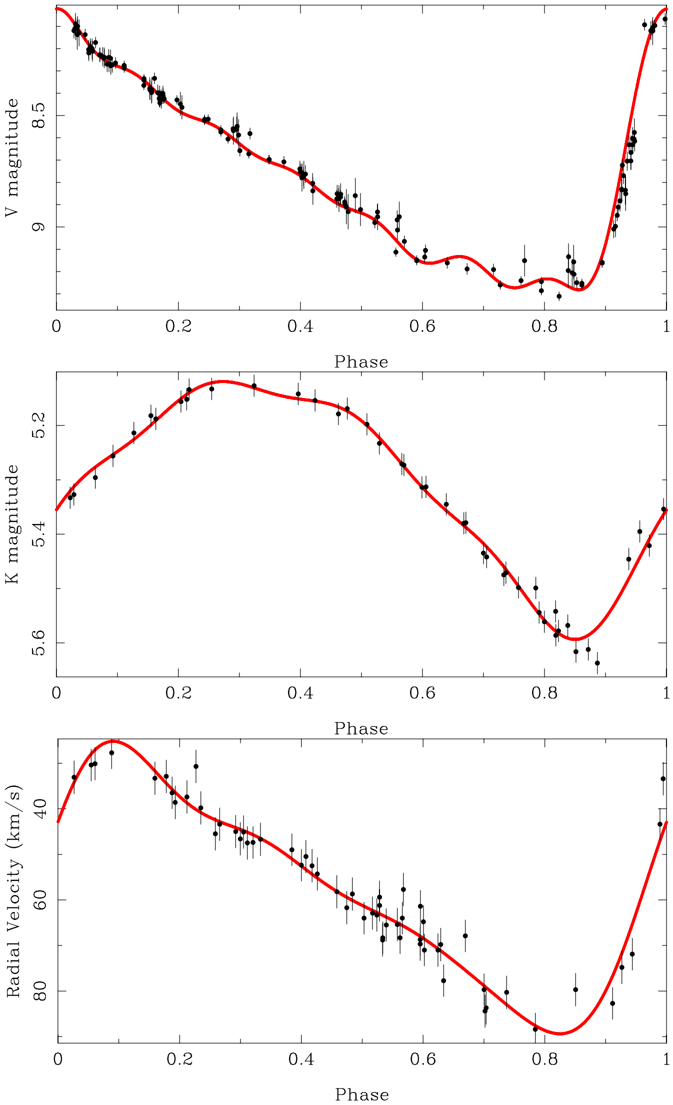

Fig. 10. Phased curves in V, K, and RV are shown for AQ Pup. Data points are shown with errors bars and the line shows the harmonic fit.

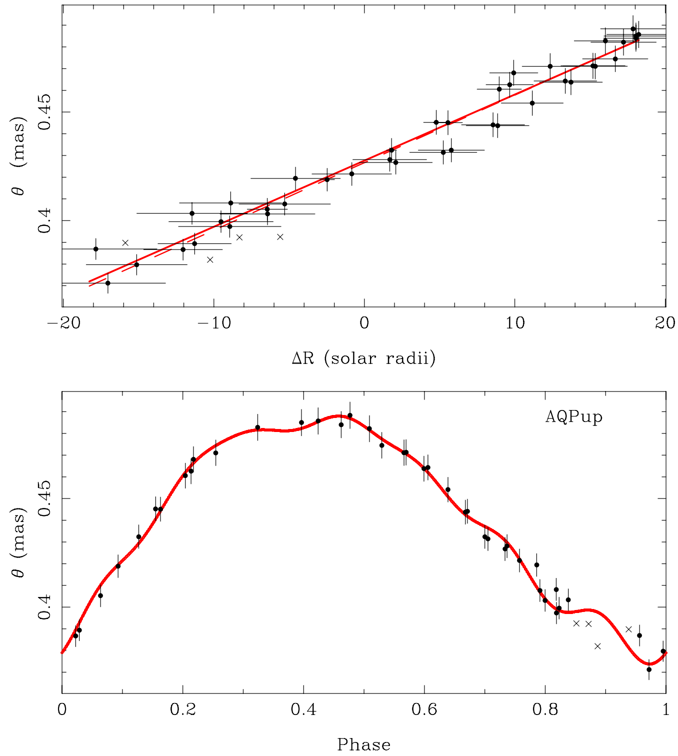

Fig. 11. For AQ Pup, the *top panel* shows the linear-bisector fit to the angular diameter as a function of radial displacement. The *bottom panel* shows the angular diameter against phase. Crosses represent data points not considered in the fit.

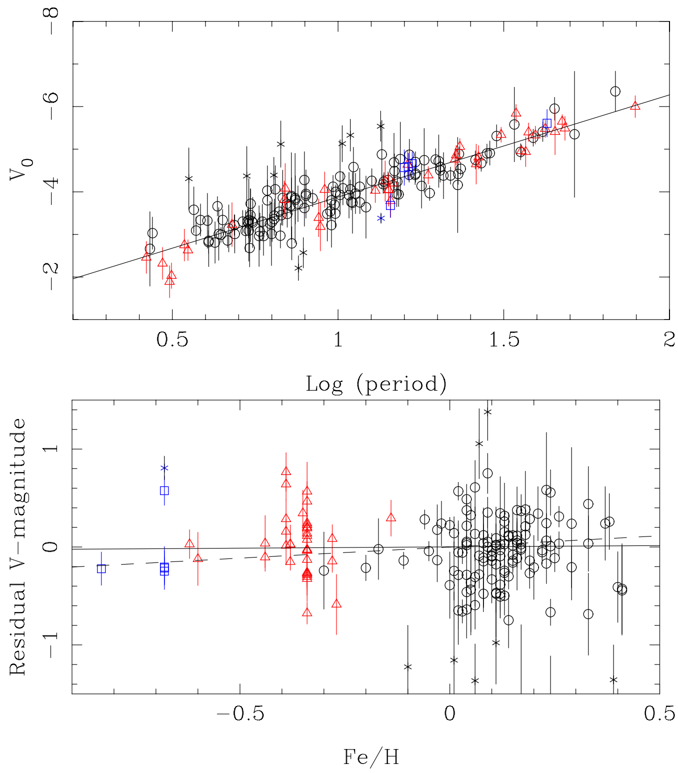

Fig. 12. The PL relation in the V-band. Galactic objects are plotted as (black) open circles, LMC Cepheids as (red) triangles, and SMC Cepheids as (blue) squares. Stars plotted with a cross symbol are excluded from the fit. The bottom panel shows the residual plotted versus metallicity. The solid line shows the fit when the residual is fitted, the solid line the dependence from a two-parameter fit (as given in Table 11).

$\log P + (1.173 \pm 0.008)$ for solar-metallicity. Both theory and radii for stars with known distances lead to slopes in the PR relation shallower than found for BW-type analysis with a constant p-factor and thus support a (steep) period dependence of the p-factor.

7. Summary and discussion

The PL relation in the V and K-band (and the corresponding Wesenheit index) and the dependence on metallicity are investigated for a sample of 128 Galactic, 6 SMC, and 36 LMC Cepheids with an individual metallicity determination from high-resolution spectroscopy. Distances are derived using the Baade-Wesselink technique implementing the most recent surface–brightness relation and estimates for the projection factor.

The slope of the p-factor relation is found to be −0.24 from demanding that the distance to the LMC does not depend on period and $(V - K)$ colour and that the slope of the PL relation in V and K be the same for the observed relations based on apparent and absolute magnitudes. This result agrees within the errors with the slope found by Storm et al. (2011a). The slope found

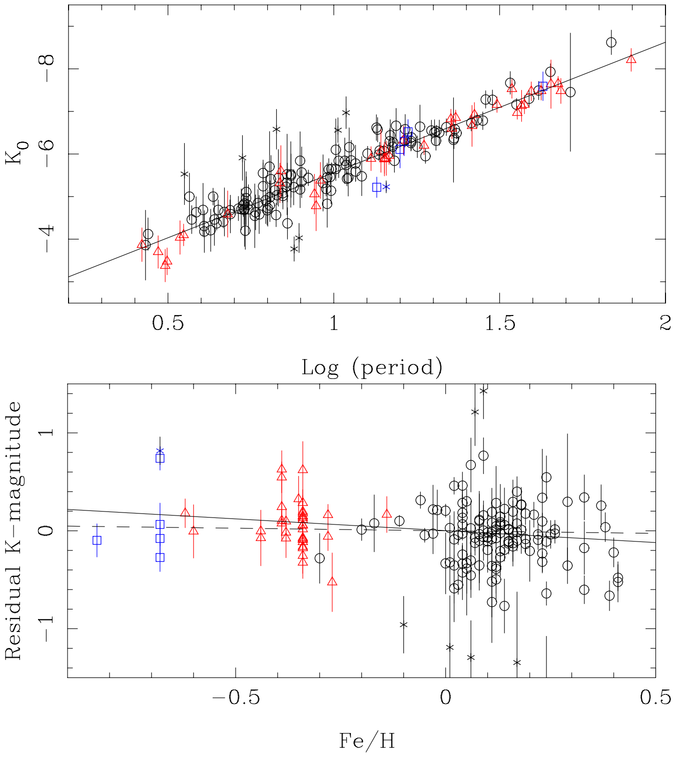

Fig. 13. As Fig. 12 in the K-band.

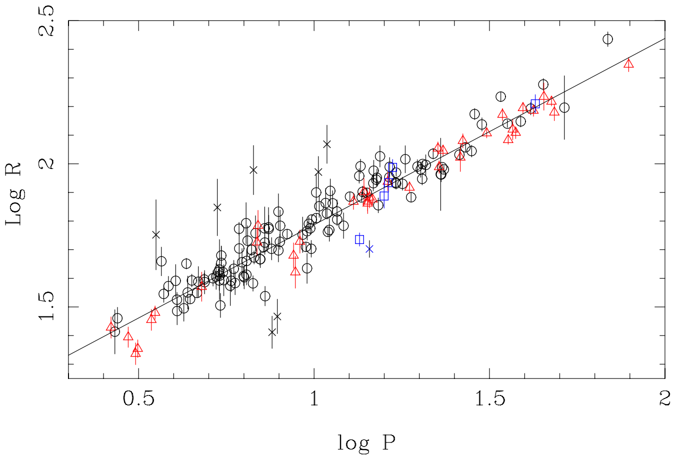

Fig. 14. The PR relation the all Cepheids. Galactic objects are plotted as (black) open circles, LMC Cepheids as (red) triangles, and SMC Cepheids as (blue) squares. Stars plotted with a cross symbol are excluded from the fit. The line is the best fit listed in Eq. (10).

by Storm et al. and in the present work is much steeper than the one predicted by theory, $p = (-0.08 \pm 0.05) \log P + (1.31 \pm 0.06)$ (Nardetto et al. 2009).

The zero point of the relation is tight to the ten Cepheids that have HST and improved HIPPARCOS parallaxes (and a cluster distance for two Cepheids) and to the 18 Cepheids that have only a cluster distance. The finally adopted relation is $p = 1.50\text{–}0.24 \log P$.

The metallicity dependence of the PL relation is investigated. No significant dependence is found in K, and $W(VK)$, and a 2σ result in V, $\gamma = +0.23 \pm 0.11$.

The distance scale found here is shorter than that in Storm et al. (2011a,b) because of the smaller p-factor found here. At a typical period of ten days, $(1.55\text{–}0.186 \log P)/(1.50\text{–}0.24 \log P) = 1.364/1.26 = 1.08$. This is reflected in the distance to the MCs. The median distance to the 36 LMC and 6 SMC Cepheids is 45.5 and 55.7 kpc (Distance Modulus (DM) of 18.29 and 18.73). The error in the mean is 0.47 and 1.4 kpc (0.02 and 0.06 in DM).

Although the absolute distances are short for the adopted p-factor, the difference in DM between SMC and LMC is 0.44 ± 0.06, which is in agreement with other independent determinations (Type II Cepheids, red clump, tip of the RGB), see the discussion in Matsunaga et al. (2011). Storm et al. (2011b) found 0.47 ± 0.14.

The difference with respect to Storm et al. in the distance scale is unlikely to be related to reddening. Their values for $E(B-V)$ have been adopted for the MC Cepheids. For the 74 Galactic Cepheids in common, the average difference in adopted $E(B-V)$ is only 0.002.

In general, however, changes in reddening do influence the derived distances. For example, the present Galactic sample has 50 stars in common with the sample in Pejcha & Kochanek (2012). The average difference in $E(B-V)$ is -0.023 (theirs minus the present work), while for 21 LMC and 3 SMC stars in common with Pejcha & Kochanek, the difference is +0.034 and +0.030.

As a test the distances were re-computed, changing all $E(B-V)$ by +0.05 for the MC Cepheids and by -0.03 for the Galactic ones. The average LMC (SMC) distance is increased by +640 (+900) pc, while the distance to the Cepheids with parallaxes and in clusters is decreased by on average -0.85%. In other words, systematic effects in $E(B-V)$ of this magnitude would increase the DM to LMC and SMC to 18.34 and 18.78, respectively.

The exact procedure of comparing BW to HST-based distances also plays a role. Here, the weighted mean of the ratio has been used. Storm et al. use the unweighted mean of the difference in distances relative to the average of the two distances. If this procedure is adopted then a distance scale longer by 3.7% is found (corresponding to DM of 18.37 and 18.81, respectively).

The distance to the LMC is shorter than most of the recent determinations, which are in the range 18.42–18.55 (Walker 2012, who quotes 49.7 kpc with a range of ±3%). Within the current framework, this difference could be reconciled by suggesting that the p-factor is larger at lower metallicity by about ~8–9% at the metallicity of both the LMC and SMC. This is not predicted by theory (Nardetto et al. 2009), but then theory currently also does not predict the steep dependence of the p-factor on period either.

Further improvements could still be made on the observational side. Metallicity determination from high-resolution spectroscopy for the 5 SMC and (a significant subset of the) 22 LMC Cepheids in the sample without such determination would likely further improve the determination of the metallicity term in the PL relation. Interferometry for more stars could improve on better constraining the surface–brightness relation, possibly further investigating the hint of a metallicity dependence noted in Sect. 4. The observations of T Vul (Gallenne et al. 2012) demonstrate that angular diameters as small as 0.60″ can be determined reliably in the K-band on 300 m baselines.

For reference, Table 12 lists the stars with minimum angular diameters ≥0.59″ and angular diameter amplitude ≥0.06″, sorted by the latter quantity. It includes objects for which interferometric observations already exist (including objects that would benefit from additional observations, like X Sgr and W Sgr).

Table 12. Galactic Cepheids with the largest angular diameters, sorted by amplitude.

Name	θ_{min} ($''$)	$\theta_{max} - \theta_{min}$ ($''$)	[Fe/H]
T Vul*	0.59	0.06	0.08
RT Aur	0.65	0.07	0.13
AW Per	0.62	0.08	0.04
S Mus	0.67	0.08	0.07
S Nor	0.64	0.08	0.13
W Gem	0.62	0.08	0.02
RX Cam	0.68	0.09	0.11
S Sge	0.73	0.09	0.15
U Sgr	0.70	0.09	0.15
U Vul	0.71	0.09	0.19
GY Sge	0.61	0.11	0.29
S Vul	0.60	0.11	0.12
U Aql	0.70	0.11	0.17
Y Sgr	0.79	0.11	0.12
Y Oph*	1.36	0.12	0.13
RY Sco	0.68	0.13	0.16
X Sgr*	1.41	0.14	–0.20
TT Aql	0.65	0.16	0.22
zeta Gem*	1.60	0.16	0.10
del Cep*	1.38	0.17	0.12
RZ Vel	0.59	0.17	0.04
X Cyg	0.70	0.18	0.17
SV Vul	0.71	0.20	0.12
beta Dor*	1.71	0.21	0.10
eta Aql*	1.65	0.21	0.15
U Car	0.86	0.22	0.04
RS Pup	0.78	0.24	0.22
T Mon	0.80	0.24	0.23
W Sgr*	1.11	0.25	0.09
l Car*	2.64	0.59	0.13

Notes. (*) A star that has been monitored interferometrically, see Table 6.

Acknowledgements. This research has made use of the SIMBAD database, operated at CDS, Strasbourg, France. M.G. would like to thank Alexandre Gallenne for providing the individual angular-diameter determinations for T Vul and FF Aql, Giuseppe Bono and Laura Inno for providing their latest results on MC PL relations before publication, and Giuseppe, Jesper Storm and Chow Choong Ngeow for commenting on a earlier version of the paper.

References

Abt, H. A. 1959, AJ, 130, 1021
Abt, H. A. 1973, ApJS, 26, 365
Abt, H. A., & Levy, S. G. 1978, PASP, 90, 188
Adams, W. S., & Shapley, H. 1918, ApJ, 47, 46
Akritas, M. G., & Bershady, M. A. 1996, ApJ, 470, 706
Albrow, M. D., & Cottrell, P. L. 1996, MNRAS, 280, 917
Alcock, C., Allsman, R. A., Axelrod, T. S., Bennett, D. P., & Cook, K. H. 1995, AJ, 109, 1653
An, D., Terndrup, D. M., & Pinsonneault, M. H. 2007, ApJ, 671, 1640
Andrievsky, S. M., Kovtyukh, V. V., Luck, R. E., et al. 2002, A&A, 381, 32
Andrievsky, S. M., Egorova, I. A., Korotin, S. A., & Kovtyukh, V. V. 2003, AN, 324, 532
Arp, H., & Thackeray, A. D. 1967, ApJ, 149, 73
Babel, J., Burki, G., Mayor, M., Chmielewski, Y., & Waelkens, C. 1989, A&A, 216, 125
Barnes, T. G., Moffett, T. J., & Slovak, M. H. 1987, ApJS, 65, 307
Barnes, T. G., Moffett, T. J., & Slovak, M. H. 1988, ApJS, 66, 43
Barnes, T. G., Fernley, J. A., Frueh, M. L., et al. 1997, PASP, 109, 645
Barnes, T. G., Jeffery, E. J., Berger, J. O., et al. 2003, ApJ, 592, 539
Barnes, T. G., Jeffery, E. J., Montemayor, T. J., & Skillen, I. 2005a, ApJS, 156, 227
Barnes, T. G., Storm, J., Jefferys, W. J., Gieren, W. P., & Fouqué, P. 2005b, ApJ, 631, 572
Beavers, W. I., & Eitter, J. J. 1986, ApJS, 62, 147
Benedict, G. F., McArthur, B. E., Feast, M. W., et al. 2007, AJ, 133, 1810
Berdnikov, L. N., Dambis, A. K., & Vozyakovs, O. V. 2000, A&AS, 143, 211
Bersier, D. 2002, ApJS, 140, 465
Bersier, D., Burki, G., Mayor, M., & Duquennoy, A. 1994, A&AS, 108, 25
Böhm-Vitense, E., Clark, M., Cottrell, P. L., & Wallerstein, G. 1990, AJ, 99, 353
Bono, G., Caputo, F., Marconi, M., & Musella, I. 2010, ApJ, 715, 277
Breger, M. 1967, MNRAS, 136, 61
Breger, M. 1970, AJ, 75, 239
Breitfellner, M. G., & Gillet, D. 1993, A&A, 277, 541
Caldwell, J. A. R., Coulson, I. M., Spencer Jones, J. H., Black, C. A., & Feast, M. W. 1986, MNRAS, 220, 671
Caldwell, J. A. R., Coulson, I. M., Dean, J. F., & Berdnikov, L. N. 2001, JAR, 7, 4
Campbell, W. W., & Moore, J. H. 1928, Lick Obs. Bull., 16, 267
Carter, B. S. 1990, MNRAS, 242, 1
Coulson, I. M. 1983, MNRAS, 203, 925
Coulson, I. M., & Caldwell, J. A. R. 1985a, SAAO Circulars, 9, 5
Coulson, I. M., & Caldwell, J. A. R. 1985b, MNRAS, 216, 671
Coulson, I. M., Caldwell, J. A. R., & Gieren, W. P. 1985, ApJS, 57, 595
Davis, J., Jacob, A. P., Robertson, J. G., et al. 2009, MNRAS, 394, 1620
Dean, J. F. 1977, MNSSA, 36, 3
Dean, J. F. 1981, SAAOC, 6, 10
Duncan, J. C. 1908, Lick Obs. Bull., 5, 82
Duncan, J. C. 1922, ApJ, 56, 340
Duncan, J. C. 1932, PASP, 44, 324
Eggen, O. J. 1977, ApJS, 34, 33
Eggen, O. J. 1983, AJ, 88, 379
Evans, N. R. 1976, ApJS, 32, 399
Evans, N. R. 1983, ApJ, 272, 214
Evans, N. R. 1988, ApJS, 66, 343
Evans, N. R., & Lyons, R. 1986, AJ, 92, 436
Evans, N. R., & Lyons, R. 1994, AJ, 107, 2164
Evans, N. R., & Sugars, B. J. A. 1997, AJ, 113, 792
Evans, N. R., & Welch, D. L. 1993, PASP, 105, 836
Evans, N. R., Welch, D. L., Scarfe, C. D., & Teays, T. J. 1990, AJ, 99, 1598
Evans, N. R., Welch, D. L., Slovak, M. H., Barnes, T. G. III, & Moffett, T. J. 1993, AJ, 106, 1599
Evans, N. R., Carpenter, K., Robinson, R., et al. 1999, ApJ, 524, 379
Evans, N. R., Vinkó, J., & Wahlgren, G. M. 2000, AJ, 120, 407
Evans, N. R., Berdnikov, L., Gorynya, N., Rastorguev, A., & Eaton, J. 2011, AJ, 142, 87
Feast, M. W. 1967, MNRAS, 136, 141
Feast, M. W. 1999, PASP, 111, 775
Feast, M. W., & Walker, A. R. 1987, ARA&A, 25, 345
Feast, M. W., Laney, C. D., Kinman, T. D., van Leeuwen, F., & Whitelock, P. A. 2008, MNRAS, 386, 2115
Fernley, J. A., Skillen, I., & Jameson, R. F. 1989, MNRAS 237, 947
Fouqué, P., & Gieren, W. P. 1997, A&A, 320, 799
Fouqué, P., Storm, J., & Gieren, W. P. 2003, in Stellar candles for the extragalactic distance scale, Lect. Notes Phys., 635, 21
Fouqué, P., Arriagada, P., Storm, J., et al. 2007, A&A, 476, 73 (F07)
Freedman, W. L., Grieve, G. R., & Madore, B. F. 1985, ApJS, 59, 311
Frost, E. B. 1906, ApJ, 23, 264
Fry, A. M., & Carney, B. W. 1997, AJ, 113, 1073
Gallenne, A., Kervella, P., Mérand, A., et al. 2012, A&A, 541, A87
Gieren, W. P. 1976, A&A 47, 211
Gieren, W. P. 1981a, ApJS, 46, 287
Gieren, W. P. 1981b, ApJS, 47, 315
Gieren, W. P. 1985, ApJ, 295, 507
Gieren, W. P. 1989a, A&A, 216, 135
Gieren, W. P. 1989b, PASP, 101, 160
Gieren, W. P., Barnes T. G., & Moffett, T. J. 1993, ApJ, 418, 135
Gieren, W. P., Welch, D. L., Mermilliod, J.-C., Matthews, J. M., & Hertling, G. 1994, AJ, 107, 2093
Gieren, W. P., Fouqué, P., & Gómez, M. 1997, ApJ, 488, 74
Gieren, W. P., Fouqué, P., & Gómez, M. 1998, ApJ, 496, 17
Gieren, W. P., Gómez, M., Storm, J., et al., 2000, ApJS, 129, 111
Gieren, W. P., Storm, J., Barnes, T. G., et al. 2005, ApJ, 627, 224
Glass, I. S. 1985, IrAJ, 17, 1
Gorynya, N. A., Samus, N. N., Berdnikov, L. N., Rastorgouev, A. S., & Sachkov, M. E. 1995, IBVS, 4199
Gorynya, N. A., Samus, N. N., Sachkov, M. E., et al. 1998, PAZh, 24, 939 (VizieR On-line Data Catalog: III/229)
Gould, A. 1994, ApJ, 426, 542
Grayzeck, E. J. 1978, AJ, 83, 1397
Groenewegen, M. A. T. 2007, A&A, 474, 975 (G07)
Groenewegen, M. A. T. 2008, A&A, 488, 25 (G08)

Groenewegen, M. A. T., Romaniello, M., Primas, F., & Mottini, M. 2004, A&A, 420, 655
Harper, W. E. 1934, Publ. DAO, 6, 151
Harris, H. C. 1980, Ph.D. Thesis, University of Washington
Häupl, W. 1988, AN, 309, 3
Henden, A. A. 1980, MNRAS, 192, 621
Herbig, G. H., & Moore, J. H. 1952, ApJ, 116, 348
Hoyle, F., Shanks, T., & Tanvir, N. R. 2003, MNRAS, 345, 269
Imbert, M. 1985, A&AS, 58, 529
Imbert, M. 1989, A&AS, 81, 339
Imbert, M. 1996, A&AS, 116, 497
Imbert, M. 1999, A&AS, 140, 79
Inno, L., Matsunaga, N., Bono, G., et al. 2012 [arXiv:1212.4376]
Isobe, T., Feigelson, E. D., Akritas, M. G., & Babu, G. J. 1990, ApJ, 364, 104
Jacob, A. Ph. 2008, Ph.D. Thesis, University of Sydney
Jacobsen, T. S. 1970, ApJ, 159, 569
Jacobsen, T. S. 1974, ApJ, 191, 691
Jacobsen, T. S., & Wallerstein, G. 1981, PASP, 93, 481
Joy, H. A. 1937, ApJ, 86, 363
Joy, H. A. 1952, ApJ, 115, 25
Kennicutt, R. C., Stetson, P. B., Saha, A., et al. 1998, ApJ, 498, 181
Kervella, P., Bersier, D., Mourard D., et al. 2004a, A&A, 428, 587
Kervella, P., Fouqué, P., Storm, J., et al. 2004b, ApJ, 604, L113
Kervella, P., Nardetto, N., Bersier, D., Mourard, D., & Coudé du Foresto, V. 2004c, A&A, 416, 941
Kienzle, F., Moskalik, P., Bersier, D., & Pont, F. 1999, A&A, 341, 818
Kimeswenger, S., Lederle, C., Richichi, A., et al. 2004, A&A, 413, 1037
Kiss, L. L. 1998, MNRAS, 297, 825
Kiss, L. L. 2000, MNRAS, 314, 420
Klagyivik, P., & Szabados, L. 2009, A&A, 504, 959
Kochanek, C. S. 1997, ApJ, 491, 13
Koen, C., Marang, F., Kilkenny, D., & Jacobs, C. 2007, MNRAS, 380, 1433
Kovtyukh, V. V., Wallerstein, G., & Andrievsky, S. M. 2005a, PASP, 117, 1173
Kovtyukh, V. V., Andrievsky, S.M., Belick, S. I., & Luck, R. E. 2005b, AJ, 129, 433
Laney, C. D., & Caldwell, J. A. R. 2007, MNRAS, 377, 147
Laney, C. D., & Stobie, R. S. 1986, SAAO Circ, 10, 51
Laney, C. D., & Stobie, R. S. 1992, A&AS, 93, 93
Lemasle, B., Francois, P., Bono, G., et al. 2007, A&A, 467, 283
Lenz, P., & Breger, M. 2005, CoAst, 146, 53
Lloyd Evans, T. 1968, MNRAS, 141, 109
Lloyd Evans, T. 1980a, SAAO Circulars, 1, 163
Lloyd Evans, T. 1980b, SAAO Circulars, 1, 257
Luck, R. E., & Andrievsky, S. M. 2004, AJ, 128, 343
Luck, R. E., & Lambert, D. L. 2011, AJ, 142, 136
Luck, R. E., Gieren, W. P., Andrievsky, S. M., et al. 2003, A&A, 401, 939
Luck, R. E., Kovtyukh, V. V., & Andrievsky, S. M. 2006, AJ, 132, 902
Luck, R. E., Andrievsky, S. M., Kovtyukh, V. V., Gieren, W., & Graczyk, D. 2011, AJ, 142, 51
Lutz, T. E., & Kelker, D. H. 1973, PASP, 85, 573
Macri, L. M., Stanek, K. Z., Bersier, D., Greenhill, L. J., & Reid, M. J. 2006, ApJ, 652, 1113
Maddrill, J. D. 1906, PASP, 18, 252
Madore, B. F. 1975, ApJS, 29, 219
Majaess, D. J., Turner, D. G., Lane, D. J., & Krajci, T. 2011, JAVSO, 39, 219
Majaess, D., Turner, D., & Gieren, W. 2012a, ApJ, 747, 145
Majaess, D., Turner, D., Gieren, W., Balam, D., & Lane, D. 2012b, ApJ, 748, L9
Majaess, D. J., Turner, D. G., Gallo, L. C., et al. 2012c, ApJ, 753, 144
Martin, W. L., & Warren, P. R. 1979, South Afr. Astr. Obs. Circ, No. 4, 98
Matsunaga, N., Feast, M. W., & Soszyński, I. 2011, MNRAS, 413, 223
McGonegal, R., McAlary, C. W., McLaren, R. A., & Madore, B. F. 1983, ApJ, 269, 641
Mérand, A., Kervella, P., Coudé du Foresto, V., et al. 2005, A&A, 438, L9
Mermilliod, J.-C., Mayor, M., & Burki, G. 1987, A&AS, 70, 389
Metzger, M. R., Caldwell, J. A. R., & Schechter, P. L. 1992, AJ, 103, 529
Metzger, M. R., Caldwell, J. A. R., McCarthy, J. K., & Schechter, P. L. 1993, ApJS, 76, 803
Moffett, T. J., & Barnes, T. G. 1984, ApJS, 55, 389
Moffett, T. J., Gieren, W. P., Barnes, T. G., & Gomez, M. 1998, ApJS, 117, 135
Monson, A. J., & Pierce, M. J. 2011, ApJS, 193, 12
Molinaro, R., Ripepi, V., Marconi, M., et al. 2011, MNRAS, 413, 942
Molinaro, R., Ripepi, V., Marconi, M., et al. 2012, ApJ, 748, 69
Moore, J. H. 1909, Lick Obs. Bull., 5, 111
Mucciarelli, A., Cristallo, S., Brocato, E., et al. 2011, MNRAS 413, 837
Nardetto, N., Mourard, D., Kervella, P., et al. 2006, A&A, 453, 309
Nardetto, N., Mourard, D., Mathias, Ph., Fokin, A., & Gillet, D. 2007, A&A, 471, 661
Nardetto, N., Gieren, W., Kervella, P., et al. 2009, A&A, 502, 951
Nardetto, N., Fokin, A., Fouqué, P., et al. 2011, A&A, 534, L16
Ngeow, C., Kanbur, S. M., & Nanthakumar, A. 2008, A&A, 477, 621
Ngeow, C.-C., Kanbur, S. M., Neilson, H. R., Nanthakumar, A., & Buonaccorsi, J. 2009, ApJ, 693, 691
Ngeow, C.-C., Neilson, H. R., Nardetto, N., & Marengo, M. 2012, A&A, accepted [arXiv:1206.1895]
Nikolaev, S., Drake, A. J., Keller, S. C., et al. 2004, ApJ, 601, 260
Niva, G. D., & Schmidt, E. G. 1979, ApJ, 234, 245
Nordgren, T. E., Lane, B. F., Hindsley, R. B., & Kervella, P. 2002, AJ, 123, 3380
Pejcha, O., & Kochanek, S. 2012, ApJ, 748, 107
Pedicelli, S., Lemasle, B., Groenewegen, M. A. T., et al. 2010, A&A, 518, A18
Pel, J. W. 1976, A&AS, 24, 413
Pel, J. W. 1985, in Cepheids: Theory and Observations, ed. B. Madore, IAU Colloq. 82 (Cambridge: Cambridge Univ. Press), 1
Petroni, S., Bono, G., Marconi, M., & Stellingwerf, R. F. 2003, ApJ, J599, 522
Petterson, O. K. L., Cottrell, P. L., & Albrow, M. D. 2004, MNRAS, 350, 95
Petterson, O. K. L., Cottrell, P. L., Albrow, M. D., & Fokin, A. 2005, MNRAS, 362, 1167
Persson, S. E., Madore, B. F., Krzemiński, W., et al. 2004, AJ, 128, 2239
Pont, F., Burki, G., & Mayor, M. 1994, A&AS, 105, 165
Pont, F., Queloz, P., Bratschl, P., & Mayor, M. 1997, A&A, 318, 416
Press, W. H., Teukolsky, S. A., Vetterling, W. T., & Flannery, B. P. 1992, in Numerical Recipes in Fortran (Cambridge University Press), 77
Rastorgouev, A. S., Gorynya, N. A., & Samus, N. N. 1997, in Binary Stellar Systems, ed. A. G. Massevich (Moscow: Kozmosinform), 123
Riess, A. G., Macri, L., & Li, W. 2009, ApJS, 183, 109
Ripepi, V., Moretti, M. I., Marconi, M., et al. 2012, MNRAS, 424, 1807
Romaniello, M., Primas, F., Mottini, M., et al. 2008, A&A, 488, 731
Romeo, G., Fusi Pecci, F., & Tosi, M. 1989, MNRAS, 240, 459
Sanford, R. F. 1927, ApJ, 66, 170
Sanford, R. F. 1935, ApJ, 81, 140
Sanford, R. F. 1951, ApJ, 114, 331
Sanford, R. F. 1956, ApJ, 123, 201
Sasselov, D. D., Beauliau, J. P., Renault, C., et al. 1997, A&A, 324, 471
Scowcroft, V., Bersier, D., Mould, J. R., & Wood, P. R. 2009, MNRAS, 396, 1287
Schechter, P. L., Avruch, I. M., Caldwell, J. A. R., & Keane, M. J. 1992, AJ, 104, 1930
Schmidt, E. G., & Seth, A. 1996, AJ, 112, 2769
Schwarz, G. 1978, Ann. Stat., 6, 461
Shappee, B. J., & Stanek, K. Z. 2011, ApJ, 733, 124
Shobbrook, R. R. 1992, MNRAS, 255, 486
Slipher, V. M. 1904, ApJ, 20, 146
Soszyński, I., Gieren, W., Pietrzyński, G., et al. 2005, PASP, 117, 823
Soszyński, I., Poleski, R., Udalski, A., et al. 2008, Acta Astron., 58, 163
Soszyński, I., Poleski, R., Udalski, A., et al. 2010, Acta Astron., 60, 17
Stibbs, D. W. N. 1955, MNRAS, 115, 363
Storm, J., Carney, B. W., Gieren, W. P., et al. 2004a, A&A, 415, 521
Storm, J., Carney, B. W., Gieren, W. P., et al. 2004b, A&A, 415, 531
Storm, J., Gieren, W. P., Fouqué, Barnes, T. G., & Gómez, M. 2005, A&A, 440, 487
Storm, J., Gieren, W., Fouqué, P., et al. 2011a, A&A, 534, A94
Storm, J., Gieren, W., Fouqué, P., et al. 2011b, A&A, 534, A95
Struve, O. 1945, ApJ, 102, 232
Sugars, B. J. A., & Evans, N. R. 1996, AJ, 112, 1670
Szabados, L. 1977, Mitt. Sternw. Ung. Akad. Wiss., Budapest, No. 70
Szabados, L. 1980, Commun. Konkoly Obs. Hung. Acad. Sci., Budapest, No. 76
Szabados, L. 1981, Commun. Konkoly Obs. Hung. Acad. Sci., Budapest, No. 77
Szabados, L. 1989, CoKon, 94, 1
Szabados, L. 1990, MNRAS, 242, 285
Szabados, L. 1991, Commun. Konkoly Obs. Hung. Acad. Sci., Budapest, No. 96
Szabados, L. 1996, A&A, 311, 189
Szabados, L. 2003, Inf. Bull. Var. Stars, No. 5394
Szabados, L., & Pont, F. 1998, A&AS, 133, 51
Tammann, G. A., Sandage, A., & Reindl, B. 2003, A&A, 404, 423
Taylor, M. M., & Booth, A. J. 1998, MNRAS, 298, 594
Taylor, M. M., Albrow, M. D., Booth, A. J., & Cottrell, P. L. 1997, MNRAS, 292, 662
ten Bruggencate, P. 1930, Harvard Circ., no. 351, 1
Testa, V., Marconi, M., Musella, I., et al. 2007, A&A, 462, 599
Turner, D. G. 1976, AJ, 81, 1125
Turner, D. G. 1977, AJ, 82, 163
Turner, D. G. 1979a, PASP, 91, 642
Turner, D. G. 1979b, A&A, 76, 350
Turner, D. G. 1986, AJ, 92, 111
Turner, D. G. 1992, AJ, 104, 1865
Turner, D. G. 1998, AJ, 116, 274

Turner, D. G. 2010, Astrophys. Space Sci., 326, 219
Turner, D. G. 2011, Rev. Mex. Astron. Astrofis., 47, 127
Turner, D. G., & Burke, J. F. 2002, AJ, 124, 2931
Turner, D. G., Forbes, D., & Pedreros, M. 1992, AJ, 104, 1132
Turner, D. G., Van Den Bergh, S., Younger, F. P., Danks, T. A., & Forbes, D. 1993, ApJS, 85, 119
Turner, D. G., Pedreros, M., & Walker, A. R. 1998, AJ, 115, 1958
Turner, D. G., Bryukhanov, I. S., Balyuk, I. I., et al. 2007, PASP, 119, 1247
Turner, D. G., Majaess, D. J., Lane, D. J., et al. 2010, OAP, 23, 119
Udalski, A., Soszyński, I., Szymański, M., et al. 1999, AcA, 49, 223
van Belle, G. T., Lane, B. F., & Thompson, R. R. 1999, AJ, 117, 521
van der Marel, R. P., & Cioni, M.-R. 2001, AJ, 122, 1807
van Genderen, A. M. 1983, A&AS, 52, 423
van Leeuwen, F. 2009, A&A, 497, 209
van Leeuwen, F., Feast, M. W., Whitelock, P. A., & Laney, C. D. 2007, MNRAS, 379, 723
Vinkó, J. 1993, MNRAS, 260, 273
Walker, A. R. 1985a, MNRAS, 213, 889
Walker, A. R. 1985b, MNRAS, 214, 45
Walker, A. R. 1987a, MNRAS, 225, 627
Walker, A. R. 1987b, SAAOC, 11, 131
Walker, A. R. 1987 c, MNRAS, 229, 31
Walker, A. R. 2012, 2012, Ap&SS, 341, 43
Wallerstein, G. 1972, PASP, 84, 656
Walraven, J. H., Tinbergen, J., & Walraven, T. 1964, BAN, 17, 520
Welch, D. L. 1985, Ph.D. Thesis, University of Toronto
Welch, D. L., & Evans, N. E. 1989, AJ, 97, 1153
Welch, D. L., Wieland, F., McAlary, C. W., et al. 1984, ApJS, 54, 547
Welch, D. L., Evans, N. R., Lyons, R. W., et al. 1987a, PASP, 99, 610
Welch, D. L., McLaren, R. A., Madore, B. F., & McAlary, C. W. 1987b, ApJ, 321, 162
Welch, D. L., Mateo, M., Cote, P., Fischer, P., & Madore, B. F. 1991, AJ, 101, 490
Wilson, T. D., Carter, M. W., Barnes, T. G., Van Citters, G. W., & Moffett, T. J. 1989, ApJS, 69, 951
Wisniewski, W. Z., & Johnson, H. R. 1968, CoLPL, 7, 57
Yong, D., Carney, B. W., Teixera de Almeida, M.-L., & Pohl, B. L. 2006, AJ, 131, 2256

Pages 15 to 25 are available in the electronic edition of the journal at http://www.aanda.org

Table 1. Sources of V-, K-band and RV data for the Galactic Cepheids.

Name	V	K	RV	Data not considered[a]
AK Cep	3	111	33	
AN Aur	3	111	33, 39	–, –, 39
AQ Pup	1, 2, 3, 4, 5, 84, 99	6, 7, 8	1, 4, 39, 44, 113	3, –, – JD < 44 100, JD > 48 500, $\dot{P}$
AV Sgr	3, 16, 112	112	16, 26, 41, 112	JD < 45 000
AW Per	2, 3, 13, 27, 30, 116	111	9, 28, 33, 39, 117, 118, 119	–, –, 9 JD < 40 000
BB Sgr	2, 3, 16, 23, 63	6, 24	20, 33, 39, 44, 47, 113	–, –, 44 JD < 44 400
BE Mon	3, 125	111	4	
beta Dor	3, 11, 16, 35	6, 18	11, 19, 20, 21, 22, 47	–, –, 20 JD < 40 000
BF Oph	2, 3, 16, 23, 63	6, 18, 24	10, 20, 39, 44, 76	JD < 36 000
BG Lac	2, 3, 12, 13	12, 111	14, 15, 39, 44	JD < 33 000
BM Per	3, 120	111	33, 121	
BN Pup	1, 3, 5, 16	6, 7	1, 17	JD < 33 000
BZ Cyg	3, 64.120	111	33	
CD Cyg	2, 3, 64	24, 111	33, 44	
CF Cas	2, 3	111	4, 17, 33, 105	
CK Sct	3, 16	111	17, 26, 105	
CP Cep	3	111	17, 33, 105	
CR Cep	2, 3	111	4, 44, 105	–, –, 44
CR Ser	3	111	33	
CS Vel	3, 120	6, 7, 24	4, 26	–, 24, –
CV Mon	2, 3, 13, 16, 23	6, 24, 111	25, 26, 44	
DD Cas	2, 3, 13	111	4, 33, 44	
delta Cep	2, 3, 11, 12, 13, 27	12, 98	4, 9, 14, 25, 28, 29, 37, 39	–, –, 9 JD < 43 500
DL Cas	2, 3, 11, 13	111	4, 33, 44, 105, 122	11, –, – JD < 40 000
DT Cyg	2, 3, 4, 27, 30, 31	24, 32	4, 9, 28, 29, 33, 79	–, 32, 9+28 JD < 33 400
eta Aql	2, 3, 12, 13, 16, 23, 27, 35	12, 24	9, 14, 20, 25, 28, 29, 36, 37	–, –, 9
FF Aql	2, 3, 11, 16, 23, 27, 30, 31	18, 24, 32	9, 20, 28, 29, 33, 38	3, 32, - JD < 44 400
FM Aql	2, 3, 12, 13, 16, 23	12, 24, 111	14, 33, 39, 44	JD < 30 000

Notes. [a] The number indicates the dataset not used in V, K, RV, respectively.

References. 1 = Coulson & Caldwell (1985a); 2 = Moffett & Barnes (1984); 3 = Berdnikov et al. (2000), a datafile named "cepheids-16-03-2006" was retrieved from the ftp address listed in that paper; 4 = Bersier et al. (1994); 5 = Madore (1975); 6 = Laney & Stobie (1992); 7 = Schechter et al. (1992); 8 = Welch (1985); 9 = Barnes et al. (1987), points with uncertainty flag ":" were removed; 10 = Stibbs (1955); 11 = Bersier (2002), data points with weight 0 and 1 in the Geneva photometry were removed; 12 = Barnes et al. (1997); 13 = Szabados (1980); 14 = Barnes et al. (2005a,b); 15 = Imbert (1999); 16 = Pel (1976); 17 = Pont et al. (1994); 18 = Lloyd Evans (1980a); 19 = Nardetto et al. (2006); 20 = Lloyd Evans (1980b); 21 = Taylor & Booth (1998); 22 = Petterson et al. (2005); 23 = Caldwell et al. (2001); 24 = Welch et al. (1984); 25 = Storm et al. (2004a,b); 26 = Metzger et al. (1992); 27 = Kiss (1998); 28 = Wilson et al. (1989); 29 = Kiss (2000); 30 = Szabados (1991); 31 = Szabados (1977); 32 = Wisniewski & Johnson (1968); 33 = Gorynya et al. (1998, VizieR On-line Data Catalog: III/229); 34 = Sanford (1935); 35 = Shobbrook (1992); 36 = Jacobsen & Wallerstein (1981); 37 = Evans (1976); 38 = Evans et al. (1990); 39 = Joy (1937); 40 = Walraven et al. (1964); 41 = Grayzeck (1978); 42 = Groenewegen (2008); 43 = Taylor et al. (1997); 44 = Barnes et al. (1988), points with uncertainty flag ":" were removed; 45 = Turner et al. (2007); 46 = Duncan (1908); 47 = Lloyd Evans (1968); 48 = Petterson et al. (2004); 49 = Campbell & Moore (1928); 50 = Böhm-Vitense et al. (1990); 51 = Mermilliod et al. (1987); 52 = Feast (1967); 53 = Breger (1970); 54 = Evans et al. (1993); 55 = Herbig & Moore (1952); 56 = Breitfellner & Gillet (1993); 57 = Adams & Shapley (1918); 58 = Abt (1959); 59 = Niva & Schmidt (1979); 60 = Gieren (1976); 61 = Häupl (1988); 62 = Beavers & Eitter (1986); 63 = Gieren (1981b); 64 = Szabados (1981); 65 = Sanford (1956); 66 = Evans et al. (1999); 67 = Frost (1906); 68 = Sanford (1927); 69 = Wallerstein (1972); 70 = Coulson (1983); 71 = Evans & Lyons (1994); 72 = Gieren (1989); 73 = Harper (1934); 74 = Coulson et al. (1985); 75 = Gieren (1985); 76 = Gieren (1981a); 77 = Jacobsen (1970); 78 = Breger (1967); 79 = Sanford (1951); 80 = Imbert (1996); 81 = Coulson & Caldwell (1985b); 82 = Eggen (1983); 83 = Evans & Sugars (1997); 84 = Hipparcos Epoch Photometry; 85 = Babel et al. (1989); 86 = Kimeswenger et al. (2004); 87 = Albrow & Cottrell (1996); 88 = Jacobsen et al. (1984); 89 = Jacobsen (1974); 90 = Henden (1980); 91 = Evans & Lyons (1992); 92 = Abt & Levy (1978); 93 = Duncan (1922); 94 = ten Bruggencate (1930); 95 = Evans & Welch (1993); 96 = Gieren (989); 97 = Sugars & Evans (1996); 98 = Fernley et al. (1989); 99 = Dean (1977); 100 = Dean (1981); 101 = Duncan (1932); 102 = Slipher (1904); 103 = Moore (1909); 104 = Feast et al. (2008); 105 = Metzger et al. (1993); 106 = Evans (1988); 107 = Maddrill (1906); 108 = Abt (1973); 109 = Imbert (1985); 110 = Joy (1952); 111 = Monson & Pierce (2011); 112 = Pedicelli et al. (2010); 113 = Storm et al. (2011a); 114 = This paper (Table 3); 115 = McGonegal et al. (1983); 116 = Vinkó (1993); 117 = Evans (1983); 118 = Evans et al. (2000); 119 = Welch & Evans (1989); 120 = Harris (1980); 121 = Pont et al. (1997); 122 = Gieren et al. (1994); 123 = Struve (1945); 124 = Welch et al. (1987a,b); 125 = Schmidt & Seth (1996); 126 = Szabados & Pont (1998); 127 = Kienzle et al. (1999).

Table 1. continued.

Name	V	K	RV	Data not considered[a]
FM Cas	2, 3, 13	111	4, 33, 44	–, –, 44
FN Aql	2, 3, 12, 13, 16, 23	12, 24, 111	14, 33, 39	–, –, 39
GH Lup	1, 3, 16, 23	6	1	JD < 43 000
GY Sge	3	6, 111	33, 105	JD < 45 500, JD > 48 200, $\dot{P}$
KN Cen	1, 3, 5, 11, 16, 40, 84	6	1, 17, 41	–, –, 41 JD < 40 000, JD > 47 000
KQ Sco	1, 3, 11	6	1, 42, 114	
l Car	3, 5, 11, 16, 35	6	11, 19, 20, 23, 43, 47	5, –, 23 JD < 46 500
LS Pup	1, 3, 11	6	1, 113, 114	–, –, 1
MW Cyg	2, 3, 13	111	33, 44, 80	–, –, 44
QZ Nor	1, 3, 11	6	26, 81, 114, 127	–, –, 81
RR Lac	2, 3, 13, 120	111	4, 33, 44	–, –, 44
RS Cas	3	111	33, 39	–, –, 39
RS Ori	2, 3, 13, 16, 30	111	33	
RS Pup	2, 3, 5, 11, 16, 84	6, 8, 24	11, 19, 25, 44	–, –, 44 JD < 42 000, JD > 50 000, $\dot{P}$
RT Aur	2, 12, 27, 31, 45	12, 32, 111	9, 28, 29, 33, 37, 46	–, 32, 9 JD < 40 000
RU Sct	2, 3, 16	6, 111	26, 33, 39, 105	–, –, 39 JD < 25 000
RW Cam	2, 3, 30, 64	111	44	
RW Cas	2, 3, 64	111	33, 44	
RX Aur	2, 3, 64	111	28, 33, 44	
RX Cam	2, 3, 13	111	33, 44, 80	JD < 40 000
RY Cas	3, 30	111	33	
RY CMa	2, 3, 16	111	33, 44	
RY Sco	1, 2, 3, 5, 11, 16	6	1, 20, 44	
RY Vel	1, 3, 5, 11, 16	6	1, 11, 17	JD < 44 000, JD > 50 000, $\dot{P}$
RZ CMa	2, 3, 16	111	17, 44	
RZ Gem	2, 3, 13	111	33, 44	
RZ Vel	1, 3, 5, 11, 16	6	1, 11, 20, 47	
S Mus	3, 11, 23, 40	6, 24	10, 11, 20, 22, 41, 47, 48, 49, 50	–, –, 41 JD < 30 000
S Nor	3, 4, 23, 40	6, 24	4, 10, 20, 41, 47, 49, 51, 52, 53	–, –, 41 JD < 30 000
S Sge	2, 3, 11, 12, 13, 23, 27, 30, 40	12, 24, 32	9, 14, 28, 29, 33, 37, 54, 55, 56	–, 32, 9+28+54
SS Sct	2, 3, 16, 23, 63	24, 111	39, 42, 44, 63, 114	JD < 30 000
ST Tau	2, 3, 12, 31, 90	111	4, 33, 44	90, –, –
SU Cas	2, 3, 9, 27, 31	12, 32	4, 9, 25, 28, 29, 33, 57, 58, 59, 60, 61, 62	–, 32, 9+28+59+61+62 JD < 43 000
SU Cyg	2, 3, 27, 30, 31	24, 111	9, 28, 33, 106, 107, 108, 109	–, –, 9 JD < 35 000
SV Mon	1, 2, 3, 64, 90	111	1, 33, 44	
SV Per	2, 3, 64, 90	111	33, 44, 121	–, –, 44
S Vul	3, 30	6, 111	33, 110	JD < 45 400, JD > 49 200, $\dot{P}$
SV Vul	2, 3, 4, 9, 27, 64	6, 12, 24, 111	4, 9, 14, 15, 25, 28, 29, 33, 39, 65	JD < 45 500, JD > 48 600, $\dot{P}$
SW Cas	2, 3, 13	111	33	
SW Vel	1, 3, 5, 11, 16, 84	6	1, 11	JD > 48 000, $\dot{P}$
SX Vel	3, 23, 40	6	10	
SY Cas	3, 31	111	4, 33	
SZ Aql	2, 3, 11, 12, 16, 23, 64	6, 12, 24, 111	11, 14, 23	
SZ Cyg	2, 3, 64	111	39, 44, 123	JD < 30 000
SZ Tau	2, 3, 4, 12, 27, 31	6, 12, 32	4, 9, 28, 29, 33	–, 32, 9 JD < 43 000, JD > 48 000, $\dot{P}$
T Mon	1, 2, 3, 11, 16, 35, 64	6, 24, 32, 111	4, 9, 25, 29, 33, 37, 48, 65, 66, 67, 68, 69, 70, 71, 72, 73	–, 32,70 JD < 44 500
TT Aql	2, 3, 11, 12, 16, 27, 64, 74	12, 24, 111	9, 11, 14, 15, 22, 25, 28, 33, 37, 39, 74	–, –, 74 JD < 47 000
T Vel	3, 16, 75	6, 18	10, 20, 75	–, 18, –
T Vul	2, 3, 4, 12, 27, 31	12, 24, 32, 98	4, 9, 14, 28, 29, 37	–, 32, 9 JD < 43 600

Table 1. continued.

Name	*V*	*K*	RV	Data not considered[a]
TW Nor	3, 5, 16, 120	6, 24	4, 26	
TY Sct	3, 16	111	26, 39, 105	–, –, 39
TZ Mon	3, 16, 121	111	17, 39, 121	JD < 40 000
U Aql	2, 3, 16, 27	111	9, 11, 20, 28, 124	–, –, 44 JD < 42 000
U Car	1, 3, 5, 11, 16, 35	6, 24	1, 11, 20	
U Nor	1, 5, 11, 16	6	1, 11, 17, 41	
U Sgr	2, 3, 4, 16, 23, 35, 63	6, 24, 32, 111, 115	4, 9, 10, 11, 20, 25, 28, 33, 39, 47, 51, 76, 77, 78	–, 32, 9 JD < 37 000
UU Mus	1, 5, 11, 40, 84	6	1, 11	
U Vul	2, 3, 12, 13, 23, 27	12, 111	4, 14, 33, 37, 44, 79, 80	–, –, 44
UZ Sct	3, 5, 16, 112	111, 112	17, 26, 39, 105, 112	JD < 47 500
V1162 Aql	3	111	33, 114	
V340 Ara	3, 5, 23	112	17, 23, 112	JD < 50 000
V340 Nor	3, 4, 82	6	4, 26, 114	
V350 Sgr	2, 3, 23, 63, 99	18, 24	20, 22, 33, 39, 44, 76, 83, 114	–, 18, 76 JD < 42 000
V386 Cyg	2, 3, 13	111	33, 44, 105	
V402 Cyg	2, 3, 31, 90	111	33, 105	90, –, –
V459 Cyg	2, 3	111	17, 33, 105	
V495 Cyg	3, 125	111	33, 105	
V496 Aql	2, 3, 16, 63	24	9, 10, 20, 33, 76, 113, 114	–, –, 9 JD < 40 500
V538 Cyg	3	111	33	
V600 Aql	2, 3, 13, 16	111	17, 33, 105	
V916 Aql	3	111	33	
V Car	3, 16, 23	6	10, 20, 47	
V Cen	3, 11, 16, 23, 63	6, 24	10, 11, 20, 47, 76	–, 24, – JD < 40 000
VW Cen	1, 3, 16, 84	6	1, 41, 114	–, –, 41
VX Cyg	3, 64, 120	111	33, 39	JD < 30 000
VX Per	2, 3, 30, 84, 120	111	33, 44, 105	30, –, –
VY Car	1, 3, 5, 11, 16, 84, 99, 100	6, 24	1, 11, 20, 41	84, –, – JD < 42 000, JD > 50 490, $\dot{P}$
VY Cyg	2, 3	111	39, 44, 123	JD < 40 000
VY Sgr	3, 16, 112	112	17, 26, 39, 112	JD < 47 000
VZ Cyg	2, 3, 12, 31	12, 24, 111	4, 14, 33, 39, 44, 113	JD < 40 000
VZ Pup	1, 3, 5, 11, 16	6, 7, 8	1, 11, 113	
W Gem	2, 3, 13, 16, 27	111	9, 28, 33	
W Sgr	2, 3, 23, 35, 40, 85	24, 32, 86	4, 9, 10, 20, 22, 28, 47, 48, 85, 87, 88, 89	–, –, 9+28 JD < 39 000,
WZ Car	1, 3, 5, 11, 16	6	1, 11	
WZ Sgr	1, 2, 3, 5, 11, 40	6, 111	1, 11, 33, 39	JD < 40 000
X Cyg	2, 3, 4, 27, 64	12, 24, 32, 98	4, 14, 25, 29, 33, 37	–, 32, –
X Lac	2, 3, 12, 13	12, 111	4, 14, 33, 44	–, 12, 44
X Pup	2, 3, 5, 11, 16, 23	6	11, 23, 44, 113	5, –, –
X Sgr	2, 3, 11, 16, 23, 35, 99	24, 32, 104	9, 10, 11, 20, 28, 47, 52, 101, 102, 103, 113	–, 32, 9 JD < 48 800
X Vul	2, 3, 13	111	4, 33, 44	–, –, 44
XX Cen	3, 11, 40, 74	6, 24	10, 11, 20, 41, 52, 74	–, 24, 41
XX Sgr	2, 3, 23	24	113, 114	JD < 44 000
Y Lac	2, 3, 12, 31, 90	12, 111	14, 15, 33, 39, 44	–, 111, - JD < 40 000
Y Oph	1, 2, 3, 16	6, 24	1, 9, 19, 20, 28, 33, 34, 91, 92	–, –, 9 JD < 40 000
Y Sct	2, 3, 16	111	11, 44	
Y Sgr	2, 3, 11, 16, 23, 35	24, 32	9, 11, 19, 20, 28, 46, 49, 93, 94, 113, 114	–, 32, 9 JD < 28 500
YZ Aur	3, 64	111	3, 39, 126	JD < 45 000
YZ Sgr	2, 3, 23, 40	24, 111	20, 44, 113	JD < 44 900
zeta Gem	2, 3, 4, 27, 35, 64	32, 104	4, 9, 19, 28, 29, 33, 37, 113	–, 32, 9 JD < 23 500
Z Lac	2, 3, 12, 64	12, 111	14, 33, 39, 44, 80, 95, 96, 97	JD < 40 500

Table 2. Sources of V-, K-band and RV data for the MC Cepheids.

Name*	V	K	RV	Data not considered[a]
HV 822*	1001, 1002, 1003	1001	1001	1002, –,–
HV 837*	1002, 1003, 1004, 1005, 1006, 1007	1008, 1009	1010	
HV 873	1002, 1004	1009, 1011	1012	–, 1009, –
HV 876	1004	1011	1012	
HV 877	1002, 1003, 1004, 1005, 1006	1008, 1009, 1011	1012	
HV 878	1002, 1004	1009, 1011	1012	
HV 879	1004, 1006, 1007	1008, 1009, 1011	1010	–, 1009, –
HV 881	1002, 1004, 1005	1009, 1011	1012	
HV 899	1002, 1004, 1006, 1007	1009, 1011	1010	1006, 1009, –
HV 900	1002, 1003, 1004, 1005, 1007	1009, 1011	1010, 1012	–, –, – JD < 44 600 JD < 51 000
HV 909	1002, 1003, 1006, 1007	1009, 1011	1010	–, 1009, –
HV 914	1004	1009, 1011	1012	–, 1009, –
HV 1005	1004, 1006	1011	1012	
HV 1006	1004	1011	1012	
HV 1023	1004, 1006	1011, 1008	1012	
HV 1328*	1001, 1003, 1004	1001, 1009	1001	–, –, – JD < 47000
HV 1333*	1001, 1004	1001	1001	
HV 1335*	1001, 1004	1001	1001	
HV 1345*	1001, 1004	1001	1001	
HV 2257	1002, 1004, 1005, 1007	1009, 1011	1010	–, 1009, – JD < 44 500, JD > 50 500, $\dot{P}$
HV 2282	1004	1011	1012	
HV 2338	1002, 1005, 1006, 1007	1009, 1011	1010	–, 1009, –
HV 2369	1002, 1003, 1004, 1005, 1006, 1013	1009, 1011	1012	JD < 44 300, $\dot{P}$
HV 2405	1004	1009, 1011	1012	
HV 2527	1004, 1006	1009, 1011	1012	
HV 2538	1004	1011	1012	
HV 2549	1003, 1004, 1006	1009, 1011	1012	
HV 2827	1003, 1006, 1007	1008, 1009, 1011	1010	–, 1008, –
HV 5655	1004	1011	1012	
HV 6093	1004	1011	1012	
HV 12197	1014, 1015, 1016, 1017	1018	1015, 1018, 1022	JD < 37 000
HV 12198	1014, 1015, 1016, 1017	1018	1001, 1016, 1018	JD < 37 000
HV 12199	1014, 1015, 1016, 1017	1018	1015, 1018, 1022	JD < 37 000
HV 12202	1014, 1015, 1016, 1017	1018, 1019	1015, 1018	–, 1019, – JD < 37 000
HV 12203	1014, 1015, 1016, 1017	1018	1015, 1018	JD < 37 000
HV 12204	1014, 1015, 1016	1018	1015, 1018	JD < 37 000
HV 12452	1004	1011	1012	
HV 12505	1004	1011	1012	
HV 12717	1004	1011	1012	
HV 12815	1003, 1006, 1007, 1020	1008, 1009, 1011	1020	–, 1009, –
HV 12816	1006, 1007, 1020	1008, 1009, 1011	1020, 1021	–, –, 1020
U 1	1004	1011	1018	

Notes. [a] The number indicates the dataset not used in V, K, RV, respectively. [*] Objects marked by a ⋆ are located in the SMC.

References. 1001 = Storm et al. (2004a,b); 1002 = Madore (1975); 1003 = Van Genderen (1983); 1004 = OGLE-III data (Soszynski et al. 2008, 2010); 1005 = Eggen (1977); 1006 = Martin & Warren (1979); 1007 = Moffett et al. (1998); 1008 = Laney & Stobie (1986); 1009 = Welch et al. (1987a,b); 1010 = Imbert (1989); 1011 = Persson et al. (2004); 1012 = Storm et al. (2011b); 1013 = Freedman et al. (1985); 1014 = Gieren et al. (2000); 1015 = Welch et al. (1991); 1016 = Walker (1987a); 1017 = Arp & Thackeray (1967); 1018 = Storm et al. (2005); 1019 = Testa et al. (2007); 1020 = Caldwell et al. (1986); 1021 = Gieren et al. (2005); 1022 = Molinaro et al. (2012).

Table 3. New radial velocity data.

JD	RV (km s^{-1})	JD	RV (km s^{-1})	JD	RV (km s^{-1})	JD	RV (km s^{-1})
KQ Sco		V340 Nor		VW Cen		Y Sgr	
2 454 625.7165	–43.06	2 454 626.5964	–47.27	2 454 626.5170	–63.59	2 454 302.5565	–9.03
2 454 626.8125	–47.14	2 454 626.6375	–47.17	2 454 626.5863	–63.60	2 454 303.7440	2.45
2 454 627.5483	–46.52	2 454 627.5619	–45.44	2 454 627.5270	–60.25	2 454 304.6563	10.42
2 454 628.6980	–45.57	2 454 628.6236	–40.48	2 454 627.6088	–59.83	2 454 305.7003	14.94
2 454 631.5682	–32.87	2 454 631.5810	–29.51	2 454 631.5496	–33.87	2 454 306.7067	–20.91
2 454 632.7716	–28.10	2 454 633.6032	–40.26	2 454 633.5906	–21.36	2 454 307.6489	–15.31
2 454 633.6530	–25.24	2 454 635.5536	–45.34	X Sct		2 454 308.6302	–6.21
2 454 953.6445	–12.65	V350 Sgr		2 454 302.7712	18.62	2 454 309.5865	2.96
LS Pup		2 454 302.5747	12.56	2 454 304.7842	–6.32	2 454 310.7130	14.48
2 454 627.4580	102.98	2 454 303.7480	25.54	2 454 305.7605	0.02	2 454 311.7705	–0.97
2 454 631.4584	66.99	2 454 304.7665	6.63	2 454 306.6959	13.83	2 454 312.7778	–20.24
2 454 635.4577	69.31	2 454 305.7794	–7.51	2 454 307.7367	31.34	2 454 331.6950	–6.40
QZ Nor		2 454 306.8017	2.13	2 454 309.7736	–2.81	2 454 332.5063	1.38
2 454 303.5850	–31.84	2 454 307.7016	12.21	2 454 310.7698	12.04	2 454 334.5199	14.87
2 454 307.6148	–30.76	2 454 308.6363	21.25	2 454 312.7944	17.84	2 454 339.5444	13.17
2 454 311.6411	–30.72	2 454 309.6259	24.82	2 454 332.6218	27.46	2 454 341.5468	–21.03
2 454 334.5106	–32.10	2 454 310.7948	–8.45	2 454 335.6077	6.87	2 454 625.8749	–8.96
2 454 341.5283	–31.64	2 454 311.6175	–1.54	2 454 341.6291	31.67	2 454 626.8939	1.02
2 454 625.5461	–30.94	2 454 312.8122	11.59	2 454 626.6591	29.84	2 454 627.6650	7.31
2 454 633.6613	–32.27	2 454 331.7205	–6.69	2 454 627.8317	2.80	2 454 630.8372	–16.37
SS Sct		2 454 332.7166	3.26	2 454 630.8799	29.94	2 454 631.8182	–7.29
2 454 625.8712	7.07	2 454 334.6189	23.99	2 454 633.6960	7.21	2 454 632.8076	2.19
2 454 627.6691	–13.88	2 454 335.5375	15.52	2 454 953.7207	23.38	2 454 633.6681	9.60
2 454 630.8872	–21.58	2 454 339.6487	20.88	XX Sgr		2 454 634.8012	14.13
2 454 631.8791	–5.11	2 454 341.6415	–9.50	2 454 302.5656	23.35	2 454 953.7064	–19.59
2 454 632.8718	7.04	2 454 625.8994	–8.11	2 454 303.7571	35.71		
2 454 633.6781	–8.44	2 454 626.6336	–0.31	2 454 304.6605	–4.33		
2 454 634.8687	–16.28	2 454 627.7019	10.97	2 454 305.7946	–2.23		
V1162 Aql		2 454 628.6315	20.74	2 454 306.7194	4.97		
2 454 302.7986	2.26	2 454 630.8919	–9.61	2 454 307.6692	12.70		
2 454 304.8177	19.95	2 454 632.8342	10.67	2 454 308.6166	18.08		
2 454 305.8033	30.86	2 454 633.6831	19.28	2 454 309.7481	36.45		
2 454 306.8129	9.31	V496 Aql		2 454 310.7181	9.30		
2 454 307.7181	–0.40	2 454 304.7716	10.86	2 454 311.7645	–4.85		
2 454 308.6830	6.64	2 454 302.5863	–0.34	2 454 312.7287	1.62		
2 454 309.5984	15.19	2 454 302.5914	–0.32	2 454 331.6906	–0.65		
2 454 310.8143	26.18	2 454 303.7521	4.29	2 454 332.5108	5.84		
2 454 311.7788	25.46	2 454 305.7241	14.40	2 454 334.5262	20.30		
2 454 312.8241	–0.59	2 454 306.7725	1.55	2 454 339.5496	10.37		
2 454 331.7254	19.79	2 454 307.7225	–5.59	2 454 341.5520	33.12		
2 454 332.7340	30.87	2 454 308.6425	–4.00	2 454 625.8782	–4.40		
2 454 333.6771	9.67	2 454 309.6342	0.67	2 454 626.8872	–3.10		
2 454 335.6354	7.36	2 454 310.7901	5.43	2 454 627.6480	2.69		
2 454 339.7009	–0.89	2 454 311.6308	11.40	2 454 630.8323	35.04		
2 454 341.6982	13.71	2 454 312.8179	12.64	2 454 631.8732	12.36		
2 454 625.9016	6.83	2 454 332.7026	14.41	2 454 632.8667	–5.53		
2 454 626.8971	16.15	2 454 335.5413	–5.49	2 454 633.6727	–0.62		
2 454 627.9075	24.67	2 454 336.6798	–0.42	2 454 634.8377	8.53		
2 454 631.7591	11.39	2 454 341.6457	–5.96	2 454 953.7113	–6.04		
2 454 632.8787	20.74	2 454 626.7744	–1.12				
2 454 633.8050	29.90	2 454 627.7452	–7.57				
		2 454 630.8954	4.48				
		2 454 633.6873	–2.61				

Table 4. Published [Fe/H] values for the Galactic Cepheids.

Name	[Fe/H]	Name	[Fe/H]
AK Cep	+0.05 (1)	S Vul	+0.12 (1)
AN Aur	–0.10 (1)	SV Vul	+0.05 (2)
AQ Pup	+0.04 (1)	SW Cas	+0.13 (2)
AV Sgr	+0.34 (2)	SW Vel	+0.00 (1)
AW Per	+0.04 (1)	SX Vel	+0.06 (1)
BB Sgr	+0.08 (2)	SY Cas	+0.04 (2)
BE Mon	0.08 (1)	SZ Aql	+0.17 (2)
beta Dor	–0.01 (3)	SZ Cyg	+0.09 (2)
BF Oph	+0.14 (1)	SZ Tau	+0.07 (2)
BG Lac	+0.07 (1)	T Mon	+0.23 (1)
BM Per	+0.23 (1)	TT Aql	+0.22 (1)
BN Pup	+0.11 (1)	T Vel	+0.04 (1)
BN Pup	+0.11 (1)	T Vul	+0.01 (2)
BZ Cyg	+0.19 (2)	TW Nor	+0.33 (1)
CD Cyg	+0.15 (1)	TY Sct	+0.37 (1)
CF Cas	+0.02 (1)	TZ Mon	+0.01 (1)
CK Sct	+0.21 (1)	U Aql	+0.17 (1)
CP Cep	–0.01 (2)	U Car	+0.04 (1)
CR Cep	–0.06 (2)	U Nor	+0.19 (1)
CS Vel	+0.12 (1)	U Sgr	+0.08 (2)
CV Mon	+0.01 (1)	UU Mus	+0.19 (1)
DD Cas	+0.10 (2)	U Vul	+0.19 (1)
delta Cep	+0.12 (1)	UZ Sct	+0.33 (2)
DL Cas	–0.01 (2)	V1162 Aql	+0.01 (2)
DT Cyg	+0.10 (2)	V340 Ara	+0.31 (2)
eta Aql	+0.08 (2)	V340 Nor	+0.16 (1)
FF Aql	+0.04 (2)	V350 Sgr	+0.18 (2)
FM Aql	+0.24 (1)	V386 Cyg	+0.11 (2)
FM Cas	–0.09 (2)	V402 Cyg	+0.02 (2)
FN Aql	–0.06 (1)	V459 Cyg	+0.09 (1)
GH Lup	+0.13 (1)	V495 Cyg	+0.24 (1)
GY Sge	+0.29 (1)	V496 Aql	+0.05 (2)
KN Cen	+0.41 (1)	V538 Cyg	+0.05 (1)
KQ Sco	+0.16 (2)	V600 Aql	+0.03 (2)
l Car	+0.13 (1)	V916 Aql	+0.39 (1)
LS Pup	-0.16 (3)	V Car	+0.04 (1)
MW Cyg	+0.09 (2)	V Cen	+0.03 (1)
QZ Nor	+0.06 (4)	VW Cen	–0.02 (3)
RR Lac	+0.04 (1)	VX Cyg	+0.09 (2)
RS Cas	+0.18 (1)	VX Per	+0.06 (1)
RS Ori	–0.10 (2)	VY Car	+0.02 (1)
RS Pup	+0.22 (1)	VY Cyg	+0.00 (2)
RT Aur	+0.13 (1)	VY Sgr	+0.26 (2)
RU Sct	+0.11 (1)	VZ Cyg	+0.05 (2)
RW Cam	+0.11 (1)	VZ Pup	–0.11 (1)
RW Cas	+0.22 (2)	W Gem	+0.02 (1)
RX Aur	+0.10 (1)	W Sgr	+0.02 (2)
RX Cam	+0.11 (1)	WZ Car	+0.05 (1)
RY Cas	+0.26 (2)	WZ Sgr	+0.19 (2)
RY CMa	+0.02 (1)	X Cyg	+0.10 (2)
RY Sco	+0.09 (2)	X Lac	+0.08 (1)
RY Vel	+0.09 (1)	X Pup	+0.08 (1)
RZ CMa	–0.03 (1)	X Sgr	–0.29 (5)
RZ Gem	–0.17 (1)	X Vul	+0.07 (2)
RZ Vel	+0.04 (1)	XX Cen	+0.18 (1)
S Mus	+0.07 (1)	XX Sgr	+0.10 (2)
S Nor	+0.13 (1)	Y Lac	+0.03 (1)
S Sge	+0.08 (2)	Y Oph	+0.06 (2)
SS Sct	+0.14 (1)	Y Sct	+0.23 (1)
ST Tau	+0.00 (1)	Y Sgr	+0.05 (2)
SU Cas	+0.06 (2)	YZ Aur	–0.30 (1)
SU Cyg	–0.03 (2)	YZ Sgr	+0.06 (2)
SV Mon	–0.03 (2)	zeta Gem	+0.10 (1)
SV Per	+0.06 (1)	Z Lac	+0.10 (1)

References. 1 = Luck & Lambert (2011); 2 = Luck et al. (2011); 3 = Romaniello et al. (2008); 4 = Fry & Carney (1997); 5 = Andrievsky et al. (2003).

Table 5. Published [Fe/H] values for the MC Cepheids.

Name	[Fe/H]	Name	[Fe/H]
HV 837	−0.83 ± 0.10 (1)	HV 877	−0.44 ± 0.10 (1)
HV 879	−0.14 ± 0.10 (1)	HV 1023	−0.28 ± 0.10 (1)
HV 2369	−0.62 ± 0.10 (1)	HV 2405	−0.27 ± 0.10 (1)
HV 2827	−0.38 ± 0.10 (1)	HV 6093	−0.60 ± 0.10 (1)
HV 12452	−0.35 ± 0.10 (1)		
HV 12197	−0.39 ± 0.05 (2)	HV 12199	−0.38 ± 0.06 (2)
HV 900	−0.38 ± 0.10 (3)	HV 909	−0.28 ± 0.10 (3)
HV 2257	−0.34 ± 0.10 (3)	HV 2338	−0.44 ± 0.10 (3)

References. 1 = Romaniello et al. (2008); 2 = Molinaro et al. (2012); 3 = Luck & Lambert (1998).

Table 6. Stars with parallaxes and/or interferometrically determined angular diameters.

Name	Period (days)	$E(B-V)$	LK (mag)	Ref.	d (pc)	Ref.	p	R ($R_\odot$)	p
T Vul	4.435421	0.064	–0.09	1	506 ± 57	4	1.781 ± 0.421 ± 0.201	33.85 ± 0.38 ± 3.81	1.32 ± 0.16
FF Aql	4.470896	0.196	–0.03	1	384 ± 24	4	1.534 ± 0.301 ± 0.096	36.17 ± 0.15 ± 2.26	0.77 ± 0.15
delta Cep	5.366250	0.075	–0.01	1, 2	272.4 ± 7.3	5, 6	1.241 ± 0.030 ± 0.033	42.43 ± 0.038 ± 1.13	1.44 ± 0.12
X Sgr	7.012745	0.237	–0.02	1	318 ± 14	7	1.025 ± 0.955 ± 0.045	49.75 ± 0.98 ± 2.19	1.300 ± 0.087
W Sgr	7.594925	0.108	–0.06	1	447 ± 38	7	1.676 ± 0.871 ± 0.143	62.1 ± 1.6 ± 5.3	2.83 ± 0.46
beta Dor	9.842554	0.052	–0.02	1	310 ± 13	7, 8	1.439 ± 0.165 ± 0.060	61.33 ± 0.34 ± 2.57	1.188 ± 0.062
zeta Gem	10.149922	0.014	–0.02	1, 3	361 ± 11	6, 7	1.349 ± 0.106 ± 0.041	65.39 ± 0.20 ± 2.00	1.265 ± 0.061
l Car	35.557209	0.147	–0.05	1	504 ± 41	9, 10	1.226 ± 0.030 ± 0.100	159.06 ± 0.27 ± 12.9	1.30 ± 0.11
eta Aql	7.176814	0.130	–	–	268 ± 1.4 ± 13.9	6, 7, 8	1.165 ± 0.148 ± 0.060	51.3 ± 2.7	–
Y Oph	17.126144	0.645	–	–	679 ± 5.1 ± 36	7	1.679 ± 0.323 ± 0.087	93.9 ± 4.9	–
RT Aur	5.4820695	0.059	–0.06	1	445 ± 38	–			1.28 ± 0.14
Y Sgr	5.7644143	0.191	–0.15	1	503 ± 75	–			1.60 ± 0.37

References. (1) van Leeuwen et al. (2007); (2) Majaess et al. (2012a); (3) Majaess et al. (2012b); (4) Gallenne et al. (2012); (5) Merand et al. (2005); (6) Nordgren et al. (2002); (7) Kervella et al. (2004); (8) Jacob (2008); (9) Davis et al. (2009); (10) Kervella et al. (2004b).

Table 10. Distances, radii, and absolute magnitudes from the BW analysis.

Name	$E(B-V)$	Period (d)	p	d (pc)	R ($R_\odot$)	M_V	M_K
				Galactic Cepheids			
AK Cep	0.635 ± 0.049	7.233310	1.294	4035.8 ± 378.2 ± 628.0	59.5 ± 5.6 ± 9.7	–3.90 ± 0.26 ± 0.47	–5.52 ± 0.20 ± 0.43
AN Aur	0.600 ± 0.057	10.289226	1.257	5301.6 ± 544.2 ± 463.4	93.6 ± 9.6 ± 8.1	–5.13 ± 0.29 ± 0.31	–6.56 ± 0.21 ± 0.20
AQ Pup	0.518 ± 0.010	30.095462	1.145	2991.1 ± 80.8 ± 141.3	137.2 ± 3.7 ± 6.6	–5.31 ± 0.07 ± 0.12	–7.27 ± 0.06 ± 0.10
AV Sgr	1.267 ± 0.078	15.411587	1.215	2452.7 ± 104.0 ± 198.3	106.2 ± 4.5 ± 8.4	–4.77 ± 0.28 ± 0.36	–6.66 ± 0.10 ± 0.18
AW Per	0.489 ± 0.011	6.463585	1.305	971.5 ± 79.4 ± 93.5	53.9 ± 4.4 ± 5.3	–4.06 ± 0.18 ± 0.23	–5.41 ± 0.17 ± 0.22
BB Sgr	0.281 ± 0.009	6.637113	1.303	814.3 ± 25.8 ± 29.0	50.0 ± 1.6 ± 1.8	–3.53 ± 0.07 ± 0.09	–5.15 ± 0.07 ± 0.08
BE Mon	0.565 ± 0.038	2.705541	1.396	1884.0 ± 283.2 ± 233.4	25.9 ± 3.9 ± 3.2	–2.66 ± 0.33 ± 0.32	–3.86 ± 0.30 ± 0.28
beta Dor	0.052 ± 0.009	9.842554	1.262	329.5 ± 6.0 ± 8.8	63.9 ± 1.2 ± 1.7	–4.00 ± 0.05 ± 0.07	–5.65 ± 0.04 ± 0.06
BF Oph	0.235 ± 0.010	4.067677	1.354	760.2 ± 32.2 ± 34.9	33.5 ± 1.4 ± 1.5	–2.82 ± 0.10 ± 0.10	–4.31 ± 0.09 ± 0.10
BG Lac	0.300 ± 0.016	5.331921	1.326	1760.4 ± 74.4 ± 78.7	41.9 ± 1.8 ± 1.9	–3.31 ± 0.10 ± 0.12	–4.80 ± 0.09 ± 0.10
BM Per	0.871 ± 0.048	22.958209	1.173	2253.4 ± 77.1 ± 740.1	91.9 ± 3.2 ± 30.9	–4.16 ± 0.18 ± 0.56	–6.33 ± 0.08 ± 0.49
BN Pup	0.416 ± 0.018	13.672436	1.227	3570.8 ± 72.8 ± 95.2	76.3 ± 1.6 ± 1.9	–4.18 ± 0.07 ± 0.09	–5.99 ± 0.04 ± 0.06
BZ Cyg	0.882 ± 0.054	10.141721	1.259	2167.7 ± 246.1 ± 251.0	79.4 ± 9.0 ± 9.3	–4.36 ± 0.30 ± 0.34	–6.10 ± 0.23 ± 0.28
CD Cyg	0.493 ± 0.015	17.074070	1.204	2267.0 ± 51.1 ± 83.1	85.9 ± 2.0 ± 3.1	–4.40 ± 0.07 ± 0.10	–6.26 ± 0.05 ± 0.08
CF Cas	0.553 ± 0.011	4.875110	1.335	2934.9 ± 187.0 ± 221.1	38.6 ± 2.5 ± 2.9	–3.01 ± 0.14 ± 0.19	–4.59 ± 0.13 ± 0.18
CK Sct	0.784 ± 0.077	7.415939	1.291	2360.3 ± 255.4 ± 319.8	60.0 ± 6.5 ± 8.1	–3.85 ± 0.35 ± 0.43	–5.52 ± 0.23 ± 0.31
CP Cep	0.702 ± 0.050	17.863306	1.200	3073.5 ± 106.3 ± 120.1	85.2 ± 3.0 ± 3.5	–4.14 ± 0.18 ± 0.21	–6.17 ± 0.08 ± 0.10
CR Cep	0.709 ± 0.016	6.233239	1.309	1299.0 ± 67.0 ± 135.2	45.3 ± 2.3 ± 4.8	–3.25 ± 0.12 ± 0.25	–4.91 ± 0.11 ± 0.25
CR Ser	0.961 ± 0.087	5.301346	1.326	2610.9 ± 413.2 ± 519.6	70.4 ± 11.1 ± 14.2	–4.37 ± 0.44 ± 0.54	–5.91 ± 0.32 ± 0.42
CS Vel	0.737 ± 0.029	5.904737	1.315	3297.7 ± 136.6 ± 182.7	43.0 ± 1.8 ± 2.4	–3.30 ± 0.13 ± 0.17	–4.85 ± 0.09 ± 0.13
CV Mon	0.722 ± 0.021	5.378664	1.325	1595.3 ± 56.9 ± 71.5	40.7 ± 1.5 ± 1.9	–3.09 ± 0.11 ± 0.13	–4.71 ± 0.08 ± 0.10
DD Cas	0.450 ± 0.016	9.811612	1.262	2406.5 ± 119.2 ± 118.3	50.5 ± 2.5 ± 2.5	–3.49 ± 0.12 ± 0.12	–5.14 ± 0.11 ± 0.11
del Cep	0.075 ± 0.009	5.366249	1.325	249.8 ± 10.5 ± 17.1	39.1 ± 1.6 ± 2.8	–3.26 ± 0.10 ± 0.15	–4.69 ± 0.09 ± 0.15
DL Cas	0.488 ± 0.010	8.000458	1.283	1845.1 ± 168.9 ± 182.6	60.7 ± 5.6 ± 6.0	–3.95 ± 0.19 ± 0.23	–5.57 ± 0.19 ± 0.23
DT Cyg	0.042 ± 0.011	2.499189	1.405	976.8 ± 250.6 ± 195.4	56.5 ± 14.5 ± 11.3	–4.31 ± 0.50 ± 0.52	–5.53 ± 0.50 ± 0.52
eta Aql	0.130 ± 0.009	7.176813	1.295	270.6 ± 6.8 ± 9.3	51.1 ± 1.3 ± 1.8	–3.67 ± 0.06 ± 0.08	–5.23 ± 0.05 ± 0.08
FF Aql	0.196 ± 0.010	4.470838	1.344	666.2 ± 80.2 ± 89.5	62.0 ± 7.5 ± 8.3	–4.39 ± 0.25 ± 0.34	–5.70 ± 0.25 ± 0.33
FM Aql	0.589 ± 0.012	6.114278	1.311	1192.0 ± 45.1 ± 47.0	59.3 ± 2.2 ± 2.3	–4.03 ± 0.09 ± 0.10	–5.55 ± 0.08 ± 0.09
FM Cas	0.325 ± 0.017	5.809293	1.317	1694.1 ± 79.5 ± 135.0	39.0 ± 1.8 ± 3.1	–3.07 ± 0.11 ± 0.20	–4.63 ± 0.10 ± 0.18
FN Aql	0.483 ± 0.009	9.481631	1.266	1172.9 ± 32.8 ± 30.6	51.3 ± 1.4 ± 1.3	–3.54 ± 0.07 ± 0.07	–5.18 ± 0.06 ± 0.06
GH Lup	0.335 ± 0.018	9.277222	1.268	1003.4 ± 67.4 ± 138.8	56.5 ± 3.8 ± 7.8	–3.48 ± 0.15 ± 0.30	–5.32 ± 0.14 ± 0.30
GY Sge	1.187 ± 0.068	51.697277	1.089	2091.6 ± 132.2 ± 624.4	157.1 ± 10.0 ± 44.8	–5.35 ± 0.27 ± 0.73	–7.45 ± 0.14 ± 0.68
KN Cen	0.797 ± 0.087	34.049845	1.132	3747.6 ± 88.9 ± 159.8	171.6 ± 4.1 ± 5.8	–5.58 ± 0.30 ± 0.35	–7.67 ± 0.06 ± 0.12
KQ Sco	0.869 ± 0.020	28.696478	1.150	2398.3 ± 55.7 ± 97.5	149.2 ± 3.5 ± 5.9	–4.91 ± 0.09 ± 0.12	–7.28 ± 0.05 ± 0.09
l Car	0.147 ± 0.013	35.557201	1.128	436.8 ± 7.2 ± 11.5	138.1 ± 2.3 ± 3.5	–4.94 ± 0.06 ± 0.08	–7.16 ± 0.04 ± 0.06
LS Pup	0.461 ± 0.015	14.147255	1.224	4470.1 ± 80.1 ± 120.8	79.3 ± 1.4 ± 2.1	–4.28 ± 0.06 ± 0.08	–6.07 ± 0.04 ± 0.06
MW Cyg	0.635 ± 0.017	5.954727	1.314	1185.8 ± 64.5 ± 95.1	38.3 ± 2.1 ± 3.1	–2.96 ± 0.13 ± 0.20	–4.58 ± 0.12 ± 0.19
QZ Nor	0.253 ± 0.016	3.786578	1.361	1394.0 ± 107.8 ± 91.2	32.0 ± 2.5 ± 2.1	–2.68 ± 0.17 ± 0.16	–4.20 ± 0.16 ± 0.15
RR Lac	0.319 ± 0.013	6.416324	1.306	1727.7 ± 79.6 ± 126.5	41.0 ± 1.9 ± 3.0	–3.36 ± 0.11 ± 0.17	–4.79 ± 0.10 ± 0.16
RS Cas	0.784 ± 0.071	6.295970	1.308	1207.3 ± 49.2 ± 79.8	40.5 ± 1.7 ± 2.7	–3.01 ± 0.25 ± 0.30	–4.68 ± 0.09 ± 0.15
RS Ori	0.352 ± 0.012	7.566893	1.289	1585.7 ± 89.8 ± 117.6	50.5 ± 2.9 ± 3.8	–3.72 ± 0.13 ± 0.18	–5.22 ± 0.12 ± 0.17
RS Pup	0.457 ± 0.009	41.457711	1.112	1567.6 ± 30.3 ± 72.4	155.9 ± 3.0 ± 7.5	–5.41 ± 0.05 ± 0.11	–7.49 ± 0.04 ± 0.10
RT Aur	0.059 ± 0.013	3.728309	1.363	473.5 ± 15.0 ± 29.9	35.1 ± 1.1 ± 2.2	–3.09 ± 0.08 ± 0.15	–4.46 ± 0.07 ± 0.15
RU Sct	0.921 ± 0.012	19.703219	1.189	1798.1 ± 82.0 ± 59.5	97.8 ± 4.5 ± 3.3	–4.76 ± 0.10 ± 0.09	–6.55 ± 0.10 ± 0.07
RW Cam	0.633 ± 0.016	16.415933	1.208	1967.8 ± 66.5 ± 139.7	97.5 ± 3.3 ± 7.0	–4.87 ± 0.09 ± 0.17	–6.58 ± 0.07 ± 0.16
RW Cas	0.380 ± 0.018	14.791859	1.219	3200.3 ± 200.8 ± 186.6	94.6 ± 6.0 ± 5.7	–4.49 ± 0.15 ± 0.15	–6.44 ± 0.13 ± 0.13
RX Aur	0.263 ± 0.012	11.624107	1.244	1546.7 ± 98.1 ± 118.7	68.1 ± 4.3 ± 5.2	–4.12 ± 0.14 ± 0.18	–5.78 ± 0.13 ± 0.17
RX Cam	0.532 ± 0.011	7.912153	1.284	818.1 ± 45.1 ± 66.8	49.9 ± 2.8 ± 4.1	–3.62 ± 0.12 ± 0.19	–5.17 ± 0.12 ± 0.18
RY Cas	0.613 ± 0.059	12.138139	1.240	2104.9 ± 130.8 ± 182.2	60.8 ± 3.8 ± 5.4	–3.64 ± 0.24 ± 0.30	–5.48 ± 0.13 ± 0.19
RY CMa	0.239 ± 0.010	4.678419	1.339	1248.2 ± 128.7 ± 99.5	38.7 ± 4.0 ± 3.1	–3.14 ± 0.22 ± 0.19	–4.64 ± 0.21 ± 0.19
RY Sco	0.718 ± 0.018	20.321239	1.186	1087.6 ± 24.4 ± 49.9	88.6 ± 2.0 ± 4.0	–4.50 ± 0.08 ± 0.12	–6.31 ± 0.05 ± 0.10
RY Vel	0.547 ± 0.010	28.124039	1.152	2002.2 ± 26.0 ± 96.1	110.8 ± 1.4 ± 5.2	–4.90 ± 0.04 ± 0.11	–6.78 ± 0.03 ± 0.10
RZ CMa	0.443 ± 0.016	4.254980	1.349	1633.3 ± 121.6 ± 133.3	31.3 ± 2.3 ± 2.6	–2.81 ± 0.16 ± 0.20	–4.21 ± 0.16 ± 0.19
RZ Gem	0.563 ± 0.025	5.529040	1.322	1990.3 ± 182.5 ± 193.9	39.2 ± 3.6 ± 3.8	–3.28 ± 0.21 ± 0.23	–4.70 ± 0.19 ± 0.22
RZ Vel	0.299 ± 0.009	20.399697	1.186	1410.6 ± 17.3 ± 38.2	99.8 ± 1.2 ± 2.6	–4.58 ± 0.04 ± 0.07	–6.54 ± 0.03 ± 0.06
S Mus	0.212 ± 0.017	9.659971	1.264	820.6 ± 33.3 ± 31.1	61.7 ± 2.5 ± 2.4	–4.12 ± 0.10 ± 0.10	–5.64 ± 0.09 ± 0.09
S Nor	0.179 ± 0.009	9.754255	1.263	814.1 ± 23.0 ± 28.4	59.5 ± 1.7 ± 2.1	–3.70 ± 0.07 ± 0.08	–5.46 ± 0.06 ± 0.07
S Sge	0.100 ± 0.010	8.382073	1.278	680.2 ± 18.1 ± 20.8	56.8 ± 1.5 ± 1.8	–3.85 ± 0.07 ± 0.08	–5.44 ± 0.06 ± 0.07
SS Sct	0.325 ± 0.009	3.671330	1.364	1394.4 ± 130.8 ± 111.2	45.6 ± 4.3 ± 3.6	–3.58 ± 0.20 ± 0.20	–5.00 ± 0.19 ± 0.20
ST Tau	0.368 ± 0.030	4.034249	1.355	1174.3 ± 118.7 ± 115.0	39.0 ± 3.9 ± 3.9	–3.32 ± 0.23 ± 0.25	–4.69 ± 0.21 ± 0.23
SU Cas	0.259 ± 0.010	1.949329	1.430	425.7 ± 26.1 ± 27.6	28.9 ± 1.8 ± 1.9	–3.03 ± 0.13 ± 0.15	–4.12 ± 0.13 ± 0.14
SU Cyg	0.098 ± 0.014	3.845553	1.360	958.5 ± 58.8 ± 53.1	37.4 ± 2.3 ± 2.0	–3.34 ± 0.14 ± 0.14	–4.63 ± 0.13 ± 0.13
SV Mon	0.234 ± 0.009	15.234488	1.216	1978.6 ± 73.2 ± 95.0	71.6 ± 2.7 ± 3.5	–3.94 ± 0.09 ± 0.12	–5.84 ± 0.08 ± 0.11
SV Per	0.408 ± 0.018	11.129260	1.249	2809.0 ± 120.6 ± 249.8	80.4 ± 3.5 ± 7.3	–4.58 ± 0.11 ± 0.22	–6.16 ± 0.09 ± 0.21
S Vul	0.727 ± 0.043	68.711152	1.059	3879.9 ± 138.7 ± 195.8	272.4 ± 9.8 ± 13.2	–6.36 ± 0.16 ± 0.19	–8.62 ± 0.08 ± 0.12

Table 10. continued.

Name	$E(B-V)$	Period (d)	p	d (pc)	R ($R_\odot$)	M_V	M_K
SV Vul	0.461 ± 0.021	45.027988	1.103	2173.5 ± 53.1 ± 72.2	189.2 ± 4.6 ± 8.2	–5.95 ± 0.09 ± 0.11	–7.93 ± 0.05 ± 0.08
SW Cas	0.467 ± 0.018	5.440909	1.323	2126.2 ± 202.8 ± 219.4	45.1 ± 4.3 ± 4.8	–3.45 ± 0.21 ± 0.25	–4.96 ± 0.20 ± 0.24
SW Vel	0.344 ± 0.009	23.439599	1.171	2088.8 ± 23.9 ± 62.3	95.6 ± 1.1 ± 2.9	–4.54 ± 0.04 ± 0.07	–6.49 ± 0.03 ± 0.06
SX Vel	0.236 ± 0.011	9.550418	1.265	1408.8 ± 126.4 ± 132.2	43.1 ± 3.9 ± 3.9	–3.22 ± 0.19 ± 0.20	–4.83 ± 0.19 ± 0.20
SY Cas	0.430 ± 0.039	4.071120	1.354	1870.5 ± 99.6 ± 190.8	30.6 ± 1.6 ± 3.2	–2.85 ± 0.17 ± 0.27	–4.18 ± 0.11 ± 0.22
SZ Aql	0.537 ± 0.016	17.139773	1.204	1863.5 ± 21.7 ± 48.3	93.2 ± 1.1 ± 2.4	–4.43 ± 0.06 ± 0.09	–6.39 ± 0.03 ± 0.06
SZ Cyg	0.571 ± 0.015	15.109910	1.217	2320.8 ± 120.0 ± 114.5	89.5 ± 4.6 ± 4.5	–4.24 ± 0.12 ± 0.12	–6.27 ± 0.11 ± 0.11
SZ Tau	0.295 ± 0.011	3.148925	1.380	599.5 ± 15.8 ± 28.2	39.1 ± 1.0 ± 1.8	–3.34 ± 0.07 ± 0.11	–4.69 ± 0.06 ± 0.10
T Mon	0.181 ± 0.011	27.032092	1.156	1125.9 ± 27.5 ± 33.0	114.0 ± 2.8 ± 3.4	–4.67 ± 0.06 ± 0.08	–6.79 ± 0.05 ± 0.07
TT Aql	0.438 ± 0.011	13.754828	1.227	987.1 ± 30.9 ± 31.1	79.9 ± 2.5 ± 2.7	–4.24 ± 0.08 ± 0.08	–6.08 ± 0.07 ± 0.07
T Vel	0.289 ± 0.009	4.639811	1.340	976.5 ± 9.8 ± 32.5	35.4 ± 0.4 ± 1.2	–2.86 ± 0.04 ± 0.08	–4.41 ± 0.02 ± 0.07
T Vul	0.064 ± 0.011	4.435422	1.345	512.8 ± 12.8 ± 14.3	33.7 ± 0.8 ± 0.9	–2.99 ± 0.06 ± 0.07	–4.37 ± 0.05 ± 0.06
TW Nor	1.157 ± 0.013	10.786356	1.252	2293.8 ± 202.5 ± 205.6	73.0 ± 6.4 ± 6.4	–3.92 ± 0.19 ± 0.21	–5.84 ± 0.18 ± 0.20
TY Sct	0.937 ± 0.059	11.053867	1.250	2004.4 ± 124.6 ± 151.0	58.7 ± 3.7 ± 4.2	–3.74 ± 0.24 ± 0.29	–5.44 ± 0.13 ± 0.17
TZ Mon	0.431 ± 0.029	7.428178	1.291	4325.6 ± 327.9 ± 385.2	59.2 ± 4.5 ± 5.3	–3.81 ± 0.19 ± 0.23	–5.49 ± 0.16 ± 0.20
U Aql	0.360 ± 0.010	7.024078	1.297	563.0 ± 25.6 ± 30.6	46.4 ± 2.1 ± 2.5	–3.48 ± 0.10 ± 0.13	–5.02 ± 0.10 ± 0.12
U Car	0.265 ± 0.010	38.819559	1.119	1401.4 ± 49.2 ± 42.2	140.7 ± 5.0 ± 4.2	–5.27 ± 0.08 ± 0.07	–7.30 ± 0.07 ± 0.07
U Nor	0.862 ± 0.024	12.644184	1.236	1364.5 ± 31.9 ± 43.5	76.7 ± 1.8 ± 2.4	–4.26 ± 0.09 ± 0.12	–6.01 ± 0.05 ± 0.07
U Sgr	0.403 ± 0.009	6.745308	1.301	584.2 ± 21.8 ± 21.2	47.1 ± 1.8 ± 1.8	–3.45 ± 0.08 ± 0.09	–5.03 ± 0.08 ± 0.08
UU Mus	0.399 ± 0.015	11.636138	1.244	2841.9 ± 59.4 ± 135.8	63.9 ± 1.3 ± 3.0	–3.75 ± 0.07 ± 0.12	–5.59 ± 0.05 ± 0.10
U Vul	0.603 ± 0.011	7.990749	1.283	651.3 ± 28.0 ± 30.2	53.4 ± 2.3 ± 2.5	–3.91 ± 0.10 ± 0.12	–5.35 ± 0.09 ± 0.10
UZ Sct	1.071 ± 0.066	14.747555	1.220	3087.7 ± 147.8 ± 140.9	85.6 ± 4.1 ± 3.8	–4.69 ± 0.24 ± 0.27	–6.30 ± 0.10 ± 0.11
V1162 Aql	0.205 ± 0.021	5.376180	1.325	1249.2 ± 123.7 ± 305.1	42.7 ± 4.2 ± 10.9	–3.34 ± 0.22 ± 0.46	–4.84 ± 0.21 ± 0.46
V340 Ara	0.546 ± 0.048	20.810876	1.184	3711.8 ± 72.7 ± 242.3	99.1 ± 2.0 ± 8.2	–4.38 ± 0.17 ± 0.23	–6.50 ± 0.05 ± 0.14
V340 Nor	0.321 ± 0.018	11.288422	1.247	1833.7 ± 120.8 ± 154.0	72.8 ± 4.8 ± 6.1	–3.96 ± 0.15 ± 0.20	–5.85 ± 0.14 ± 0.19
V350 Sgr	0.299 ± 0.009	5.154258	1.329	916.5 ± 24.6 ± 51.7	39.8 ± 1.1 ± 2.3	–3.30 ± 0.07 ± 0.12	–4.72 ± 0.06 ± 0.13
V386 Cyg	0.841 ± 0.017	5.257679	1.327	978.0 ± 54.6 ± 90.2	40.4 ± 2.3 ± 3.8	–3.08 ± 0.13 ± 0.22	–4.70 ± 0.12 ± 0.21
V402 Cyg	0.391 ± 0.025	4.364891	1.346	2094.5 ± 222.1 ± 192.1	35.5 ± 3.8 ± 3.3	–3.01 ± 0.23 ± 0.23	–4.46 ± 0.22 ± 0.21
V459 Cyg	0.730 ± 0.018	7.251260	1.294	1573.4 ± 90.5 ± 99.2	34.5 ± 2.0 ± 2.0	–2.79 ± 0.14 ± 0.15	–4.37 ± 0.12 ± 0.14
V495 Cyg	0.977 ± 0.055	6.718375	1.301	3181.2 ± 469.3 ± 506.6	95.1 ± 14.0 ± 15.4	–5.12 ± 0.36 ± 0.41	–6.58 ± 0.30 ± 0.36
V496 Aql	0.397 ± 0.010	6.807017	1.300	1157.4 ± 123.8 ± 123.2	57.2 ± 6.1 ± 6.2	–3.86 ± 0.22 ± 0.26	–5.44 ± 0.22 ± 0.25
V538 Cyg	0.642 ± 0.059	6.119215	1.311	2684.6 ± 222.2 ± 295.1	50.6 ± 4.2 ± 5.8	–3.80 ± 0.26 ± 0.34	–5.24 ± 0.17 ± 0.26
V600 Aql	0.798 ± 0.016	7.238847	1.294	1811.8 ± 97.0 ± 157.7	53.1 ± 2.8 ± 4.6	–3.87 ± 0.12 ± 0.21	–5.33 ± 0.11 ± 0.20
V916 Aql	1.089 ± 0.064	13.442663	1.229	3591.9 ± 97.1 ± 204.6	90.7 ± 2.5 ± 4.9	–5.54 ± 0.22 ± 0.28	–6.62 ± 0.06 ± 0.14
V Car	0.169 ± 0.010	6.696707	1.302	910.2 ± 30.7 ± 50.4	38.2 ± 1.3 ± 2.1	–2.97 ± 0.08 ± 0.13	–4.57 ± 0.07 ± 0.12
V Cen	0.292 ± 0.012	5.493980	1.322	694.1 ± 18.1 ± 25.2	41.8 ± 1.1 ± 1.5	–3.31 ± 0.07 ± 0.09	–4.81 ± 0.06 ± 0.08
VW Cen	0.428 ± 0.022	15.037338	1.217	3687.2 ± 62.7 ± 169.6	88.1 ± 1.5 ± 4.0	–3.95 ± 0.09 ± 0.13	–6.17 ± 0.04 ± 0.10
VX Cyg	0.830 ± 0.058	20.133213	1.187	2618.8 ± 127.2 ± 115.8	95.5 ± 4.7 ± 4.0	–4.72 ± 0.22 ± 0.24	–6.51 ± 0.11 ± 0.10
VX Per	0.475 ± 0.011	10.886268	1.251	4139.4 ± 488.9 ± 483.6	117.0 ± 13.8 ± 13.8	–5.33 ± 0.25 ± 0.28	–6.97 ± 0.24 ± 0.29
VY Car	0.237 ± 0.009	18.904990	1.194	1363.4 ± 33.1 ± 41.0	76.4 ± 1.9 ± 2.3	–3.97 ± 0.06 ± 0.07	–5.95 ± 0.05 ± 0.07
VY Cyg	0.606 ± 0.018	7.857165	1.285	1091.9 ± 76.5 ± 145.7	29.3 ± 2.1 ± 3.8	–2.57 ± 0.16 ± 0.32	–4.03 ± 0.15 ± 0.31
VY Sgr	1.283 ± 0.077	13.558324	1.228	2702.0 ± 71.2 ± 143.9	98.0 ± 2.6 ± 5.2	–4.88 ± 0.27 ± 0.32	–6.57 ± 0.06 ± 0.13
VZ Cyg	0.266 ± 0.011	4.864379	1.335	1848.7 ± 65.6 ± 74.3	39.4 ± 1.4 ± 1.6	–3.22 ± 0.08 ± 0.10	–4.68 ± 0.08 ± 0.09
VZ Pup	0.459 ± 0.011	23.174946	1.172	4134.1 ± 62.9 ± 98.2	97.3 ± 1.5 ± 2.3	–4.89 ± 0.05 ± 0.07	–6.58 ± 0.03 ± 0.05
W Gem	0.255 ± 0.010	7.913488	1.284	1222.7 ± 126.4 ± 143.1	68.0 ± 7.0 ± 8.0	–4.28 ± 0.22 ± 0.27	–5.84 ± 0.21 ± 0.27
W Sgr	0.108 ± 0.011	7.594968	1.289	203.3 ± 22.8 ± 16.1	25.8 ± 2.9 ± 2.1	–2.21 ± 0.23 ± 0.18	–3.77 ± 0.23 ± 0.17
WZ Car	0.370 ± 0.011	23.015214	1.173	3217.4 ± 46.1 ± 164.5	91.6 ± 1.3 ± 5.2	–4.42 ± 0.05 ± 0.12	–6.37 ± 0.03 ± 0.12
WZ Sgr	0.431 ± 0.011	21.850159	1.179	1619.8 ± 51.7 ± 47.0	108.5 ± 3.5 ± 3.2	–4.38 ± 0.08 ± 0.07	–6.63 ± 0.07 ± 0.07
X Cyg	0.228 ± 0.011	16.385764	1.209	1036.2 ± 24.1 ± 27.9	89.7 ± 2.1 ± 2.5	–4.40 ± 0.06 ± 0.07	–6.32 ± 0.05 ± 0.06
X Lac	0.336 ± 0.011	5.444534	1.323	1604.7 ± 97.5 ± 86.5	47.8 ± 2.9 ± 2.5	–3.72 ± 0.13 ± 0.13	–5.11 ± 0.13 ± 0.12
X Pup	0.402 ± 0.009	25.965762	1.161	2533.8 ± 40.2 ± 104.8	107.7 ± 1.7 ± 4.8	–4.75 ± 0.05 ± 0.10	–6.73 ± 0.03 ± 0.09
X Sgr	0.237 ± 0.015	7.012747	1.297	317.4 ± 8.1 ± 14.5	46.4 ± 1.2 ± 2.1	–3.72 ± 0.07 ± 0.11	–5.08 ± 0.05 ± 0.10
X Vul	0.742 ± 0.019	6.319553	1.308	870.1 ± 54.2 ± 64.2	40.1 ± 2.5 ± 3.0	–3.29 ± 0.15 ± 0.19	–4.73 ± 0.13 ± 0.17
XX Cen	0.266 ± 0.011	10.953515	1.251	1402.4 ± 37.2 ± 39.5	57.8 ± 1.5 ± 1.6	–3.76 ± 0.07 ± 0.07	–5.42 ± 0.06 ± 0.06
XX Sgr	0.521 ± 0.016	6.424310	1.306	1327.3 ± 91.2 ± 77.2	45.8 ± 3.2 ± 2.7	–3.44 ± 0.15 ± 0.14	–4.99 ± 0.14 ± 0.13
Y Lac	0.207 ± 0.016	4.323760	1.347	2683.6 ± 81.7 ± 81.1	44.8 ± 1.4 ± 1.4	–3.66 ± 0.08 ± 0.09	–5.00 ± 0.07 ± 0.07
Y Oph	0.645 ± 0.015	17.126144	1.204	558.7 ± 17.6 ± 19.8	85.4 ± 2.7 ± 3.0	–4.70 ± 0.08 ± 0.10	–6.30 ± 0.07 ± 0.08
Y Sct	0.757 ± 0.012	10.341254	1.257	1770.0 ± 113.5 ± 119.2	71.1 ± 4.6 ± 4.8	–4.08 ± 0.14 ± 0.15	–5.84 ± 0.13 ± 0.15
Y Sgr	0.191 ± 0.009	5.773372	1.317	415.2 ± 57.8 ± 42.2	37.5 ± 5.2 ± 3.9	–2.96 ± 0.28 ± 0.25	–4.55 ± 0.28 ± 0.25
YZ Aur	0.601 ± 0.058	18.192968	1.198	4245.2 ± 219.8 ± 428.5	103.7 ± 5.4 ± 10.7	–4.74 ± 0.23 ± 0.32	–6.64 ± 0.11 ± 0.23
YZ Sgr	0.281 ± 0.010	9.553741	1.265	1119.7 ± 61.7 ± 57.8	58.2 ± 3.2 ± 3.0	–3.80 ± 0.12 ± 0.12	–5.45 ± 0.12 ± 0.12
zeta Gem	0.014 ± 0.009	10.149922	1.258	359.3 ± 9.2 ± 10.2	64.7 ± 1.6 ± 1.8	–3.93 ± 0.07 ± 0.07	–5.65 ± 0.05 ± 0.06
Z Lac	0.370 ± 0.011	10.885697	1.251	1813.0 ± 44.0 ± 70.1	67.0 ± 1.6 ± 2.6	–4.06 ± 0.06 ± 0.10	–5.74 ± 0.05 ± 0.09

Table 10. continued.

Name	$E(B-V)$	Period (d)	p	d (pc)	R ($R_\odot$)	M_V	M_K
				LMC Cepheids			
HV 1005	0.100 ± 0.005	18.714651	1.195	44096.6 ± 1787.4 ± 1141.7	82.6 ± 3.4 ± 2.1	–4.39 ± 0.09 ± 0.06	–6.20 ± 0.09 ± 0.06
HV 1006	0.100 ± 0.005	14.216644	1.223	42626.4 ± 1557.0 ± 3293.9	73.9 ± 2.7 ± 5.3	–4.04 ± 0.08 ± 0.17	–5.90 ± 0.08 ± 0.16
HV 1023	0.070 ± 0.005	26.554194	1.158	48109.6 ± 1770.2 ± 2438.1	120.3 ± 4.5 ± 5.5	–4.81 ± 0.08 ± 0.12	–6.92 ± 0.08 ± 0.12
HV 12197	0.060 ± 0.005	3.143795	1.381	38519.9 ± 2388.9 ± 1541.2	22.6 ± 1.4 ± 0.9	–2.03 ± 0.13 ± 0.09	–3.48 ± 0.13 ± 0.09
HV 12198	0.060 ± 0.005	3.522766	1.369	47828.2 ± 1786.8 ± 2073.1	30.2 ± 1.1 ± 1.3	–2.63 ± 0.08 ± 0.10	–4.10 ± 0.08 ± 0.10
HV 12199	0.060 ± 0.005	2.639167	1.399	51317.8 ± 3516.8 ± 3040.6	26.8 ± 1.8 ± 1.6	–2.46 ± 0.14 ± 0.14	–3.87 ± 0.14 ± 0.14
HV 12202	0.060 ± 0.005	3.101216	1.382	35765.2 ± 2292.9 ± 2234.2	21.7 ± 1.4 ± 1.4	–1.89 ± 0.14 ± 0.14	–3.38 ± 0.13 ± 0.14
HV 12203	0.060 ± 0.004	2.954123	1.387	44902.6 ± 2957.3 ± 2481.8	24.8 ± 1.6 ± 1.4	–2.32 ± 0.14 ± 0.14	–3.70 ± 0.14 ± 0.13
HV 12204	0.060 ± 0.005	3.438749	1.371	45433.9 ± 2154.3 ± 3331.3	28.5 ± 1.4 ± 2.1	–2.75 ± 0.10 ± 0.17	–4.04 ± 0.10 ± 0.17
HV 12452	0.058 ± 0.005	8.738897	1.274	39620.7 ± 1448.4 ± 3968.2	47.8 ± 1.8 ± 4.8	–3.39 ± 0.08 ± 0.22	–5.06 ± 0.08 ± 0.22
HV 12505	0.100 ± 0.005	14.393280	1.222	46661.2 ± 1577.9 ± 4095.0	76.3 ± 2.6 ± 6.2	–3.79 ± 0.07 ± 0.19	–5.90 ± 0.07 ± 0.19
HV 12717	0.058 ± 0.005	8.843849	1.273	35477.4 ± 3154.6 ± 3676.3	41.8 ± 3.7 ± 4.4	–3.18 ± 0.19 ± 0.23	–4.78 ± 0.18 ± 0.23
HV 12815	0.070 ± 0.005	26.115120	1.160	39034.2 ± 2303.9 ± 3812.0	105.2 ± 6.2 ± 11.0	–4.65 ± 0.13 ± 0.21	–6.66 ± 0.12 ± 0.21
HV 12816	0.070 ± 0.005	9.108991	1.270	47026.6 ± 3305.1 ± 3137.1	53.5 ± 3.8 ± 3.6	–4.05 ± 0.15 ± 0.16	–5.38 ± 0.15 ± 0.15
HV 2257	0.060 ± 0.005	39.388561	1.117	46153.9 ± 1085.6 ± 2119.3	156.6 ± 3.7 ± 6.5	–5.33 ± 0.05 ± 0.10	–7.47 ± 0.05 ± 0.10
HV 2282	0.100 ± 0.005	14.677123	1.220	44678.3 ± 1082.1 ± 1790.5	75.1 ± 1.8 ± 2.9	–4.20 ± 0.05 ± 0.09	–5.96 ± 0.05 ± 0.09
HV 2338	0.040 ± 0.005	42.194159	1.110	43337.5 ± 0707.4 ± 1935.7	153.4 ± 2.5 ± 6.8	–5.48 ± 0.04 ± 0.10	–7.48 ± 0.04 ± 0.10
HV 2369	0.095 ± 0.005	48.392674	1.096	37861.3 ± 1268.6 ± 2233.8	151.2 ± 5.1 ± 9.2	–5.49 ± 0.07 ± 0.13	–7.48 ± 0.07 ± 0.13
HV 2405	0.070 ± 0.005	6.923455	1.298	63519.3 ± 5494.6 ± 6336.9	60.8 ± 5.3 ± 6.0	–4.08 ± 0.18 ± 0.25	–5.60 ± 0.18 ± 0.24
HV 2527	0.070 ± 0.005	12.949600	1.233	49165.1 ± 2326.8 ± 2290.7	73.8 ± 3.5 ± 3.4	–4.03 ± 0.10 ± 0.11	–5.89 ± 0.10 ± 0.10
HV 2538	0.100 ± 0.005	13.871003	1.226	48045.6 ± 3441.4 ± 4496.4	79.8 ± 5.7 ± 7.2	–4.25 ± 0.15 ± 0.20	–6.07 ± 0.15 ± 0.20
HV 2549	0.058 ± 0.005	16.218520	1.210	45696.6 ± 2762.6 ± 2200.1	86.7 ± 5.3 ± 4.2	–4.64 ± 0.13 ± 0.11	–6.32 ± 0.13 ± 0.11
HV 2827	0.080 ± 0.005	78.824495	1.045	40791.1 ± 1652.4 ± 1721.4	222.2 ± 9.0 ± 9.6	–6.00 ± 0.09 ± 0.10	–8.21 ± 0.09 ± 0.10
HV 5655	0.100 ± 0.005	14.212586	1.223	45859.2 ± 2057.8 ± 3650.0	72.7 ± 3.3 ± 5.3	–4.05 ± 0.10 ± 0.18	–5.88 ± 0.10 ± 0.17
HV 6093	0.058 ± 0.005	4.784880	1.337	47300.7 ± 3548.0 ± 4795.1	37.2 ± 2.8 ± 3.7	–3.23 ± 0.16 ± 0.22	–4.59 ± 0.16 ± 0.22
HV 873	0.130 ± 0.005	34.436191	1.131	50117.9 ± 1128.8 ± 2200.7	148.5 ± 3.4 ± 6.7	–5.84 ± 0.05 ± 0.10	–7.53 ± 0.05 ± 0.10
HV 876	0.100 ± 0.005	22.715624	1.174	44756.6 ± 1588.5 ± 1883.9	97.4 ± 3.5 ± 3.8	–4.86 ± 0.08 ± 0.09	–6.60 ± 0.08 ± 0.09
HV 877	0.100 ± 0.005	45.158119	1.103	49137.9 ± 2137.0 ± 5164.0	171.7 ± 7.5 ± 18.4	–5.41 ± 0.09 ± 0.27	–7.64 ± 0.09 ± 0.27
HV 878	0.058 ± 0.005	23.306146	1.172	49845.2 ± 1349.1 ± 1707.2	111.2 ± 3.0 ± 3.9	–5.06 ± 0.06 ± 0.08	–6.85 ± 0.06 ± 0.07
HV 879	0.060 ± 0.005	36.831567	1.124	43030.6 ± 2890.7 ± 2305.0	131.8 ± 8.9 ± 7.3	–4.94 ± 0.14 ± 0.12	–7.13 ± 0.14 ± 0.12
HV 881	0.030 ± 0.005	35.743231	1.127	40336.0 ± 0949.4 ± 1065.7	121.2 ± 2.9 ± 3.2	–4.96 ± 0.05 ± 0.06	–6.97 ± 0.05 ± 0.06
HV 899	0.110 ± 0.005	31.050706	1.142	47670.4 ± 1231.5 ± 1397.6	128.0 ± 3.3 ± 3.8	–5.34 ± 0.06 ± 0.07	–7.16 ± 0.06 ± 0.07
HV 900	0.058 ± 0.005	47.481696	1.098	45391.7 ± 0988.8 ± 1358.3	165.0 ± 3.6 ± 4.7	–5.65 ± 0.05 ± 0.07	–7.65 ± 0.05 ± 0.07
HV 909	0.058 ± 0.005	37.558988	1.122	40579.0 ± 1215.3 ± 1637.7	128.5 ± 3.9 ± 5.0	–5.40 ± 0.07 ± 0.09	–7.16 ± 0.06 ± 0.09
HV 914	0.070 ± 0.005	6.878394	1.299	50856.1 ± 5016.2 ± 2652.7	53.2 ± 5.3 ± 2.8	–3.81 ± 0.20 ± 0.12	–5.32 ± 0.20 ± 0.12
U 1	0.100 ± 0.005	22.542693	1.175	52497.2 ± 1546.8 ± 2528.2	113.2 ± 3.4 ± 5.1	–4.76 ± 0.07 ± 0.11	–6.82 ± 0.06 ± 0.10
				SMC Cepheids			
HV 1345	0.030 ± 0.005	13.478117	1.229	41067.2 ± 1705.7 ± 1484.6	54.4 ± 2.3 ± 1.9	–3.38 ± 0.09 ± 0.08	–5.22 ± 0.09 ± 0.08
HV 1335	0.090 ± 0.005	14.380836	1.222	43362.0 ± 1891.0 ± 2268.8	50.4 ± 2.2 ± 2.8	–3.68 ± 0.09 ± 0.12	–5.23 ± 0.09 ± 0.11
HV 1328	0.004 ± 0.003	15.835971	1.212	55005.4 ± 3950.6 ± 4054.3	77.2 ± 5.5 ± 5.8	–4.57 ± 0.15 ± 0.16	–6.11 ± 0.15 ± 0.16
HV 1333	0.070 ± 0.005	16.295258	1.209	65988.1 ± 2898.9 ± 4126.9	85.9 ± 3.8 ± 5.6	–4.59 ± 0.09 ± 0.14	–6.29 ± 0.09 ± 0.14
HV 822	0.030 ± 0.005	16.742306	1.206	67441.1 ± 2403.2 ± 3533.0	97.2 ± 3.5 ± 5.4	–4.66 ± 0.08 ± 0.12	–6.52 ± 0.08 ± 0.12
HV 837	0.042 ± 0.005	42.705045	1.109	56363.4 ± 3097.9 ± 2949.2	162.1 ± 8.9 ± 8.5	–5.61 ± 0.12 ± 0.12	–7.59 ± 0.12 ± 0.12

Appendix A: Cluster distances

It is not our intention to give a review on the distances to Galactic clusters containing Cepheids. Recent compilations of distances can be found in Turner (2010) and Tammann et al. (2003). The latter is based on Feast (1999), which is an update of Feast & Walker (1987), with detailed remarks in Walker (1987b).

However, when comparing cluster distances quoted in the literature to the BW distances obtained here and checking the literature in more detail, it was obvious that not all distances were given on the same distance scale. In addition, some results obtained since Turner (2010) can be included in the analysis.

Traditionally, the distances to clusters are based on Zero Age Main Sequence (ZAMS) fitting using BV data and a reference ZAMS, which is very often that of Turner (1976, 1979a). It is tied to a DM to the Pleiades of 5.56.

Recently, Turner, Majaess and co-workers used ZAMS fitting with 2MASS JHK data to derive distances to Cepheids containing clusters. The procedure is outlined in Majaess et al. (2011), and the distances to nine benchmark open clusters thathave HST and revised HIPPARCOS-based distances (van Leeuwen 2009) determined. There is the well-known disagreement for the Pleiades, but the infrared ZAMS fitting distances to the other clusters, and the comparison to the Hyades and Pleiades that have HST-based parallaxes is excellent. The 2MASS-based ZAMS fitting is therefore tied to a DM of 5.65 for the Pleiades, which is thus different from that implied when using the Turner ZAMS in the optical.

In Table A.1, the adopted cluster-based DM are listed for the Cepheids in the sample. Infrared ZAMS fitting is preferred over earlier work in the optical. Where appropriate, the older work is scaled to the adopted Pleiades distance. A few Cepheids in clusters that are in our sample, but where the association is uncertain or the DM in the literature are very discrepant, have not been considered: KQ Sco, GY Sge, T Mon, SV Vul (see Hoyle et al. 2003)

Table A.1. Distances to cluster containing Cepheids.

Name Cepheid	Name Cluster	Adopted DM	Method	Reference	Remarks
BB Sgr	Collinder 394	9.38 ± 0.10	JHK	Turner (2010)	
V Cen	NGC 5662	9.28 ± 0.05	JHK	Turner (2010)	
RU Sct	Trumpler 35	11.11 ± 0.10	JHK	Turner (2010)	
SU Cyg	Turner 9	9.33 ± 0.05	JHK	Turner (2010)	
S Vul	Anon Vul OB	12.47 ± 0.29	JHK	Turner (2011)	
delta Cep	Cep OB6	7.21 ± 0.13	JHK	Majaess et al. (2012a)	
zeta Gem	ADS 5742	7.75 ± 0.09	JHK	Majaess et al. (2012b)	
SU Cas	Alessi 95	8.04 ± 0.08	JHK	Majaess et al. (2012c)	
VY Car	Car OB2	11.66 ± 0.15*	BV	Turner (1977)	includes a +0.09 correction in DM
RZ Vel	Vel OB1	11.32 ± 0.15*	BV	Turner (1979b)	includes a +0.09 correction in DM
CS Vel	Ruprecht 79	12.55 ± 0.16	BV	Walker (1987c)	includes a +0.08 correction in DM
SZ Tau	NGC 1647	8.76 ± 0.02	BV	Turner (1992)	includes a +0.09 correction in DM
SW Vel	Vel OB 5	12.08 ± 0.15	BV	Turner et al. (1993)	includes a +0.09 correction in DM
X Cyg	Ruprecht 175	10.52 ± 0.04	BV	Turner (1998)	includes a +0.09 correction in DM
U Sgr	IC 4725	9.05 ± 0.09	BV	*a*	*a*
DL Cas	NGC 129	11.10 ± 0.07	BV	*b*	*b*
S Nor	NGC 6087	9.82 ± 0.18	BV	*c*	*c*
TW Nor	Lynga 6	11.40 ± 0.12	BV	*d*	*d*
QZ Nor, V340 Nor	NGC 6067	11.15 ± 0.09	BV	*e*	*e*
CV Mon	vandenBergh 1	11.12 ± 0.15	BV	*f*	*f*
WZ Sgr	Turner 2	11.31 ± 0.10	BV	*g*	*g*
CF Cas	NGC 7790	12.63 ± 0.11	BV	*h*	*h*

Notes. [a] The average of the distances quoted in An et al. (2007; 8.93 ± 0.08 plus a +0.02 correction), Hoyle et al. (2003; 9.08 ± 0.18 plus a +0.09 correction), and Pel et al. (1985; 8.95 ± 0.10 plus a +0.08 correction). [b] The average of the distances quoted in Turner et al. (1992; 11.11 ± 0.02 plus a +0.09 correction), An et al. (2007; 11.04 ± 0.05 plus a +0.02 correction), and Hoyle et al. (2003; 10.94 ± 0.14 plus a +0.09 correction). [c] The average of the distances quoted in Turner (1986; 9.78 ± 0.03 plus a +0.09 correction), An et al. (2007; 9.65 ± 0.06 plus a +0.02 correction), and Pel et al. (1985; 9.84 ± 0.10 plus a +0.08 correction). [d] The average of the distances quoted in An et al. (2007; 11.51 ± 0.13 plus a +0.02 correction), Hoyle et al. (2003; 11.33 ± 0.18 plus a +0.09 correction), and Walker et al. (1985a; 11.15 ± 0.3 plus a +0.09 correction). [e] The average of the distances quoted in An et al. (2007; 11.03 ± 0.08 plus a +0.02 correction), Hoyle et al. (2003; 11.18 ± 0.12 plus a +0.09 correction), and Walker et al. (1985b; 11.05 ± 0.10 plus a +0.09 correction). [f] Three distance determinations have been considered: Turner et al. (1998; 11.08 ± 0.03 plus a +0.09 correction, adopting $E(B-V) = 0.75$), An et al. (2007; 10.74 ± 0.21 plus a +0.02 correction, adopting $E(B-V) = 0.57$), and Hoyle et al. (2003; 11.34 ± 0.21 plus a +0.09 correction, adopting $E(B-V) = 0.90$). The adopted distance is the average of the three, but the dispersion is large. This is likely due to the very different reddenings adopted. If a correction is made to a reddening of 0.75, adopting Δ DM/Δ E(B-V) ~ 2 (An et al. 2007), then the average becomes 11.14 with a very small dispersion. [g] The average of the distances quoted in Turner et al. (1993; 11.26 ± 0.10 plus a +0.09 correction), and Hoyle et al. (2003; 11.18 ± 0.16 plus a +0.09 correction). [h] The average of the distances quoted in An et al. (2007; 12.46 ± 0.11 plus a +0.02 correction), Hoyle et al. (2003; 12.58 ± 0.14 plus a +0.09 correction), and Romeo et al. (1989; 12.65 ± 0.15 plus a +0.08 correction). [*] No error quoted, conservative error adopted.