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Comparison of the Galactic Cepheid Open Cluster and Surface Brightness Distance Scales

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Abstract. We compare the best determined Baade-Wesselink (BW) period-luminosity (PL) relation for 100 galactic Cepheids to the PL relation derived for 32 open cluster and association Cepheids by the ZAMS-fitting method. Eighteen stars in common lead to the conclusion that BW and ZAMS-fitting distances can agree to better than 0.1 mag, after proper allowance of systematic effects in both methods.

Gieren & Fouqué (1993; = GF) have calibrated the ZAMS-fitting distance scale on 32 galactic Cepheids which are presumably all members in open clusters and associations. They used as a reference cluster the Pleiades assuming $\mu_0 = 5.57$ (van Leeuwen 1983) in spite of recent indications (Gatewood et al. 1990, Feast 1991) that the Pleiades distance is more likely to be $\sim$5.70. For details on how the true cluster distance moduli were derived, see GF.

Among the 32 Cepheids with ZAMS-fitting distances, 18 have now BW distance determinations from the surface brightness method (see Gieren et al. 1993). For four of these stars (CF Cas, CV Mon, SZ Tau and UY Per) we have derived new improved distances; the underlying new data will be published elsewhere. These distances and the corresponding absolute magnitudes are given in Table 1.

Comparing these data with the ZAMS-fitting moduli, it is found that the BW moduli are, on average, 0.23 ± 0.10 mag larger. There are five Cepheids for which the discrepancy between the determinations from both methods is larger than 0.6 mag; omitting these stars as yet unreliable for a comparison of both methods of distance determination, the mean difference between BW and ZAMS-fitting moduli reduces to 0.15 ± 0.06.

We conclude that the agreement between both methods is encouraging, if we regard possible systematic errors in each method: ZAMS-fitting is affected by absorption uncertainties, metallicity differences among clusters, Pleiades zero-point and location of the Cepheid into the sparse associations. The BW method is affected by metallicity, surface gravity, and microturbulence differences among Cepheids; it also exhibits systematic differences according to which colour is adopted to predict surface brightness. Adopting infrared colours which are less

affected by secondary effects, and which reduce the BW radii (Laney & Stobie 1995), and hence the distances by several percent, we may safely conclude that ZAMS-fitting and BW distance moduli agree within 0.1 mag, for the galactic sample. Applying the calibration to extragalactic samples is another matter as, for example, the limited range of metallicity observed in our Galaxy needs extrapolation if one goes to the Magellanic Clouds.

Table 1. Metallicity-corrected surface brightness distances and absolute magnitudes of 18 open cluster and association Cepheids

Cepheid	log P (days)	distance (pc)	σ (pc)	M_V^{SB}(mag)	μ_0^{SB} (mag)	μ_0^{ZAMS}† (mag)	$\mu_0^{SB} - \mu_0^{ZAMS}$ (mag)
EV Sct	0.4901	1370	110	-2.66	10.69	10.88	-0.19
SZ Tau	0.4982	580	40	-3.22	8.82	8.68	+0.14
QZ Nor	0.5782	1740	190	-3.23	11.20	11.13	+0.07
CF Cas	0.6880	3130	160	-3.15	12.48	12.68	-0.20
UY Per	0.7296	1560	110	-2.57	10.97	11.70	-0.73
CV Mon	0.7307	2160	150	-3.67	11.67	11.22	+0.45
V Cen	0.7399	920	50	-3.92	9.82	9.11	+0.71
BB Sgr	0.8220	770	90	-3.41	9.42	9.05	+0.37
U Sgr	0.8290	640	40	-3.66	9.04	8.95	+0.09
DL Cas	0.9031	2030	110	-4.20	11.54	11.12	+0.42
ζ Gem	1.0065	410	70	-4.18	8.05	7.75	+0.30
VY Car	1.2767	2600	150	-5.38	12.08	11.42	+0.66
RZ Vel	1.3096	1870	110	-5.32	11.36	11.24	+0.12
WZ Sgr	1.3394	2610	210	-5.59	12.08	11.27	+0.81
SW Vel	1.3700	2750	140	-5.18	12.20	12.00	+0.20
T Mon	1.4317	1770	100	-5.77	11.24	11.02	+0.22
RS Pup	1.6172	2580	300	-6.51	12.06	11.28	+0.78
SV Vul	1.6532	2330	160	-6.48	11.83	11.82	+0.01

† Values from Gieren & Fouqué, AJ, 106, 734, 1993.

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