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ORIGINAL ARTICLE

Metallicity calibration and photometric parallax estimation: I. *UBV* photometry

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Abstract We present metallicity and photometric parallax calibrations for the F and G type dwarfs with photometric, astrometric and spectroscopic data. The sample consists of 168 dwarf stars covering the colour, iron abundance and absolute magnitude intervals $0.30 < (B-V)_0 < 0.68$ mag, $-2.0 < \mathrm{[Fe/H]} < 0.4$ dex and $3.4 < M_V < 6.0$ mag, respectively. The means and standard deviations of the metallicity and absolute magnitude residuals are small, i.e. $\langle \Delta\mathrm{[Fe/H]}_{res}\rangle = 0$ and $\sigma = 0.134$ dex, and $\langle \Delta(M_V)_{res}\rangle = 0$ and $\sigma = 0.174$ mag, respectively, which indicate accurate metallicity and photometric parallax estimations.

Keywords Stars: abundances · Stars: metallicity calibration · Stars: distance

1 Introduction

Stellar metallicity and kinematics are two important means to understand the formation and evolution of our Galaxy. Metallicity of a star can be determined spectroscopically or photometrically. One needs more accurate analyses for the first procedure which can be carried out only for nearby stars, while the second one, the photometric procedure, can be applied to stars at large distances as well. The second procedure has a long history. We are indebted to Roman (1955) who discovered the correlation between the weakness of the spectral lines and the ultra-violet (UV) excess, $\delta(U-B)$, of the stars.

It has been a custom to use the $(U-B)\times(B-V)$ two-colour diagram of the Hyades cluster to estimate the $\delta(U-B)$ colour excesses, i.e. $\delta(U-B)$ of a star is the difference between the UV colours of the given star and the Hyades' star with the same $B-V$ colour. Schwarzschild et al. (1955), Sandage and Eggen (1959) and Wallerstein (1962) interpreted the UV excess with the "blanketing model", i.e. the UV excesses of the stars, with the same metal abundance but different $B-V$ colours are different. This is important for the red stars where the blanketing line is parallel to the intrinsic Hyades line and hence $\delta(U-B)$ is guillotined. Sandage (1969) used a procedure to normalize the UV excesses, as explained in the following. He separated 112 high proper motion stars into 16 sub-samples with mean colours $B-V = 0.35, 0.40, 0.45, \ldots, 1.10$, and compared the UV excess for each colour, $\delta(U-B)$, with the one for $(B-V)_0 = 0.6$, $\delta_{0.6}(U-B)$, which is the maximum UV excess for a given star. Then, he adopted the ratio $\delta(U-B)_{0.6}/\delta(U-B)$ as a normalized factor for the UV excess for the corresponding $B-V$ colour.

Carney (1979) normalized the UV excesses of 101 dwarfs using the procedure of Sandage (1969) and calibrated them to the iron abundance [Fe/H]. Karaali et al. (2003) improved this calibration using a different procedure and 88 dwarf stars. These calibrations provide iron abundances in the *UBV* photometry. Other studies offered calibration in different photometries, including *UBV*, (i.e. Walraven and Walraven 1960; Strömgren 1966; Cameron 1985; Laird et al. 1988; Buser and Fenkart 1990; Trefzger et al. 1995). Two recent metallicity calibrations which provide iron abundances with *UBV* photometry are those of Karataş and Schuster (2006) and Karaali et al. (2011).

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The distance of a star is an important parameter in investigation of the kinematic structure of our Galaxy which can be determined via trigonometric or photometric parallaxes. Trigonometric parallax procedure can be applied only to nearby stars. *Hipparcos* (ESA 1997; van Leeuwen 2007) is the main source for this parallax. For stars at large distances, only photometric parallax is available, which is the combination of the apparent and absolute magnitude of a star in question. Absolute magnitude estimation is another problem for the researchers. The widely used procedure for absolute magnitude estimation is based on the offset from a standard main-sequence, where Hyades is generally used for this purpose (Laird et al. 1988; Nissen and Schuster 1991; Karaali et al. 2003; Karataş and Schuster 2006).

The colour-absolute magnitude of a specific cluster can also be used for absolute magnitude estimation of stars in a given population, such as thin and thick discs, and halo. The cluster is chosen such that its metallicity is compatible with the mean metallicity of the population in question. Details for this procedure can be found in Phleps et al. (2000), Chen et al. (2001), and Siegel et al. (2002).

In this study, we present two calibrations; one for the iron abundance [Fe/H], and another one for the absolute magnitude offset ΔM_V, in terms of reduced UV excess, $\delta_{0.6}(U-B)$. We used the reduced *Hipparcos* astrometric data (van Leeuwen 2007) for the first time and improved both the metallicity and absolute magnitude calibrations. We organized the paper as follows. The data are presented in Sect. 2. The procedure is given in Sect. 3, and Sect. 4 is devoted to Summary and Discussion.

2 Data

The data used in our study is a combination of the star samples given in four spectroscopic studies, i.e. Bensby et al. (2014), Nissen and Schuster (2010), Reddy et al. (2006), and Venn et al. (2004). We separated the F-G dwarf stars in these studies with the temperature and surface gravity constraints of Cox (2000), i.e. $5310 < T_{eff}(K) < 7300$, and $\log g > 4$ (cgs) and reduced the multiple observations to a single one. The number of stars taken from the mentioned studies in the order given above which supply the constraints of Cox (2000) are 263, 83, 51, and 32, respectively. After excluding the binary and variable stars from the sample, as well as the multiple observations, the total star sample reduced to 168. The iron abundances of these stars were also taken from the mentioned four spectroscopic studies. We used the reduced *Hipparcos* parallaxes (van Leeuwen 2007) and estimated the distances of the sample stars using the following equation:

$$d\ (\text{pc}) = 1000/\pi\ (\text{mas}). \tag{1}$$

The V apparent magnitudes and, $U-B$ and $B-V$ colours of the sample stars are provided from the catalogue of Mermilliod (1997) and they are de-reddened by the procedure explained in the following. We adopted the total absorption for the model, A_∞, (Schlafly and Finkbeiner 2011) and estimated the total absorption for the distance of the star, A_d, by the following equation of Bahcall and Soneira (1980):

$$A_d(b) = A_\infty(b)\left[1 - \exp\left(\frac{-|d\ \sin(b)|}{H}\right)\right], \tag{2}$$

where b and d are the Galactic latitude and distance of the star, respectively, and H is the scale-height of the dust ($H = 125$ pc; Marshall et al. 2006). Then, the colour excess of the star, $E_d(B-V)$, could be estimated by the following equation of Cardelli et al. (1989) and was used in the evaluation of the colour excess $E_d(U-B)$ given by Garcia et al. (1988):

$$E_d(B-V) = A_d(b)/3.1, \tag{3}$$

$$E_d(U-B) = 0.72 \times E_d(B-V) + 0.05 \times E_d(B-V)^2. \tag{4}$$

Finally, the de-reddened V_0 magnitude and colour indices are:

$$\begin{aligned} V_0 &= V - 3.1 \times E_d(B-V),\\ (B-V)_0 &= (B-V) - E_d(B-V),\\ (U-B)_0 &= (U-B) - E_d(U-B). \end{aligned} \tag{5}$$

Thus, we estimated the absolute magnitudes of the stars using the necessary parameters in the well known Pogson equation, i.e.

$$V_0 - M_V = 5 \times \log d - 5. \tag{6}$$

Data for the 168 sample stars are given in Table 1. They cover the colour range $0.30 < (B-V)_0 < 0.68$ mag. The distributions of the iron abundance, relative parallax errors and the absolute magnitudes are given in Figs. 1, 2 and 3. The mode value of the metallicity histogram in Fig. 1 corresponds to -0.3 dex, while the iron abundances cover the range $-2 <$ [Fe/H] $< +0.4$ dex. However, the number of stars with [Fe/H] < -1.2 and [Fe/H] > 0.2 dex are only 14. The number of stars with relative parallax error $\sigma_\pi/\pi \leq 0.1$ is 141, which comprise about 84% of the complete sample. The mode value of absolute magnitudes of the sample stars is calculated to be $M_V = 4.5$ mag. The absolute magnitudes in Fig. 3 range from 3.4 to 6.0 mag. The data for the two-colour diagram, $(U-B)_0 \times (B-V)_0$, and $M_V \times (B-V)_0$ colour-absolute magnitude diagram for the Hyades cluster were taken from Sandage (1969) and Karaali et al. (2003), respectively, and then

Table 1 Data for the sample stars used in our study. The columns give: ID, Equatorial coordinates, Hipparcos number, V apparent magnitude, $U-B$ and $B-V$ colours, colour excess reduced to the distance of the star ($E_d(B-V)$), parallax and its error (π), effective temperature (T_{eff}), surface gravity ($\log g$), iron abundance ([Fe/H]), and reference

ID	α_{2000} (hh:mm:ss.ss)	δ_{2000} (dd:mm:ss.s)	Hip	V (mag)	$U-B$ (mag)	$B-V$ (mag)	$E_d(B-V)$ (mag)	π (mas)	T_{eff} (K)	$\log g$ (cgs)	[Fe/H] (dex)	Authors
1	00 05 54.70	+18 14 06.0	493	7.450	0.040	0.560	0.005	26.93 ± 0.56	5826	4.36	−0.29	2004AJ....128.1177V
2	00 11 15.86	−15 28 04.7	910	4.895	−0.014	0.492	0.003	53.34 ± 0.64	6289	4.17	−0.33	2014A&A...562A..71B
3	00 20 04.26	−64 52 29.3	1599	4.228	0.018	0.572	0.001	116.46 ± 0.60	5932	4.33	−0.19	2014A&A...562A..71B
4	00 25 01.42	−30 41 51.7	1976	7.560	0.155	0.615	0.004	21.27 ± 0.70	5982	4.32	0.19	2014A&A...562A..71B
5	00 34 27.83	−52 22 23.1	2711	5.569	−0.016	0.466	0.002	39.24 ± 0.34	6499	4.22	0.06	2014A&A...562A..71B
6	00 40 32.24	−29 52 05.8	3182	8.720	0.090	0.635	0.008	16.76 ± 0.98	5643	4.32	−0.29	2014A&A...562A..71B
7	00 44 26.65	−26 30 56.4	3479	7.783	0.156	0.665	0.002	30.89 ± 0.75	5563	4.40	−0.26	2014A&A...562A..71B
8	00 44 39.27	−65 38 58.3	3497	6.544	0.107	0.654	0.002	45.34 ± 0.32	5638	4.41	−0.32	2014A&A...562A..71B
9	00 47 30.75	−36 56 24.7	3704	7.831	−0.041	0.540	0.004	20.51 ± 0.78	6078	4.40	−0.35	2014A&A...562A..71B
10	00 50 07.59	−10 38 39.6	3909	5.187	−0.003	0.510	0.003	63.48 ± 0.35	6352	4.45	−0.03	2014A&A...562A..71B
11	00 58 11.69	+80 06 49.3	4544	9.780	−0.100	0.540	0.048	9.23 ± 1.03	5832	4.51	−0.87	2006MNRAS.367.1329R
12	01 02 49.72	−37 18 58.2	4892	8.516	0.008	0.580	0.005	16.48 ± 1.04	5994	4.42	−0.29	2014A&A...562A..71B
13	01 06 05.15	+01 42 23.1	5163	9.448	0.000	0.594	0.010	10.84 ± 1.29	5547	4.63	−0.74	2006MNRAS.367.1329R
14	01 07 48.66	−08 14 01.3	5301	8.440	0.170	0.650	0.018	18.23 ± 0.76	5686	4.39	−0.11	2014A&A...562A..71B
15	01 15 11.12	−45 31 54.0	5862	4.957	0.098	0.571	0.001	66.16 ± 0.24	6145	4.24	0.17	2014A&A...562A..71B
16	01 18 59.99	−08 56 22.2	6159	8.898	−0.019	0.595	0.012	15.35 ± 1.17	5653	4.56	−0.67	2006MNRAS.367.1329R
17	01 32 57.60	+23 41 44.0	7217	9.040	0.062	0.624	0.026	14.60 ± 1.14	5550	4.20	−0.48	2004AJ....128.1177V
18	01 36 05.80	−61 05 03.0	7459	10.100	−0.160	0.530	0.010	10.87 ± 1.33	5759	4.31	−1.23	2010A&A...511L..10N
19	01 42 29.32	−53 44 27.0	7978	5.540	−0.004	0.530	0.003	57.36 ± 0.25	6219	4.41	0.05	2014A&A...562A..71B
20	01 53 57.68	+10 36 50.5	8859	6.780	−0.050	0.460	0.016	24.12 ± 0.64	6420	4.21	−0.30	2014A&A...562A..71B
21	01 56 59.98	−51 45 58.5	9085	6.097	−0.060	0.480	0.003	37.22 ± 0.38	6334	4.29	−0.26	2014A&A...562A..71B
22	02 14 40.30	−01 12 05.1	10449	9.081	−0.071	0.579	0.008	15.87 ± 1.23	5566	4.64	−0.87	2006MNRAS.367.1329R
23	02 17 07.14	+21 34 00.5	10652	9.042	0.012	0.620	0.028	15.93 ± 1.19	5499	4.58	−0.67	2006MNRAS.367.1329R
24	02 38 21.50	+02 26 44.4	12294	10.528	−0.158	0.462	0.019	5.82 ± 2.18	6069	4.58	−0.95	2006MNRAS.367.1329R
25	02 38 27.86	+30 48 59.9	12306	7.359	−0.003	0.586	0.017	29.17 ± 0.81	5832	4.44	−0.52	2014A&A...562A..71B
26	02 40 12.42	−09 27 10.4	12444	5.775	−0.011	0.520	0.003	45.96 ± 0.41	6383	4.41	0.09	2014A&A...562A..71B
27	02 42 33.47	−50 48 01.1	12653	5.403	0.075	0.556	0.003	58.25 ± 0.22	6375	4.73	0.27	2014A&A...562A..71B
28	02 44 12.00	+49 13 42.0	12777	4.100	−0.007	0.485	0.003	89.87 ± 0.22	5309	4.30	−0.02	2004AJ....128.1177V
29	02 45 41.01	−38 09 31.4	12889	7.637	0.046	0.580	0.004	20.16 ± 0.69	5999	4.23	−0.13	2014A&A...562A..71B

Table 1 (*Continued*)

ID	α_{2000} (hh:mm:ss.ss)	δ_{2000} (dd:mm:ss.s)	Hip	V (mag)	$U-B$ (mag)	$B-V$ (mag)	$E_d(B-V)$ (mag)	π (mas)	T_{eff} (K)	$\log g$ (cgs)	[Fe/H] (dex)	Authors
30	02 51 58.36	+11 22 11.9	13366	8.383	−0.061	0.547	0.048	16.39 ± 1.07	5856	4.26	−0.69	2014A&A...562A..71B
31	03 03 38.96	−05 39 58.7	14241	8.085	0.117	0.670	0.012	28.54 ± 0.97	5430	4.33	−0.45	2014A&A...562A..71B
32	03 15 06.39	−45 39 53.4	15131	6.760	−0.020	0.580	0.004	41.34 ± 0.40	5985	4.54	−0.43	2014A&A...562A..71B
33	03 15 22.52	−01 10 43.1	15158	8.550	0.030	0.530	0.029	10.55 ± 1.15	6191	4.18	−0.06	2014A&A...562A..71B
34	03 18 19.98	+18 10 17.8	15381	7.540	0.170	0.620	0.022	20.16 ± 0.64	5882	4.24	0.08	2014A&A...562A..71B
35	03 28 21.08	−06 31 51.3	16169	8.238	0.028	0.621	0.009	21.38 ± 0.88	5650	4.34	−0.57	2014A&A...562A..71B
36	03 40 22.06	−03 13 01.1	17147	6.689	−0.086	0.540	0.008	39.12 ± 0.56	5970	4.52	−0.81	2014A&A...562A..71B
37	04 52 09.91	−27 03 51.0	22632	9.134	−0.190	0.490	0.009	15.00 ± 1.13	5909	4.22	−1.62	2014A&A...562A..71B
38	05 03 53.95	−41 44 41.8	23555	6.302	0.040	0.530	0.002	31.50 ± 0.31	6466	4.64	0.22	2014A&A...562A..71B
39	05 05 28.70	+40 15 26.0	23688	9.660	−0.160	0.420	0.004	8.79 ± 1.20	6293	4.41	−0.89	2010A&A...511L..10N
40	05 09 56.96	+05 33 26.7	24030	9.720	−0.130	0.520	0.023	8.66 ± 1.77	5738	4.64	−1.00	2006MNRAS.367.1329R
41	05 31 13.78	+15 46 24.4	25860	8.635	0.118	0.669	0.042	20.07 ± 1.15	5543	4.56	−0.35	2006MNRAS.367.1329R
42	05 39 27.44	+03 57 02.7	26617	10.350	0.030	0.630	0.076	8.79 ± 2.67	5429	4.67	−0.75	2006MNRAS.367.1329R
43	05 44 27.79	−22 26 54.2	27072	3.590	−0.007	0.481	0.001	112.02 ± 0.18	6323	4.16	−0.02	2014A&A...562A..71B
44	05 59 55.79	−37 03 24.2	28403	8.594	0.050	0.626	0.006	19.64 ± 0.72	5668	4.31	−0.33	2014A&A...562A..71B
45	06 03 14.86	+19 21 38.7	28671	9.310	−0.043	0.618	0.016	16.81 ± 2.04	5396	4.39	−1.11	2014A&A...562A..71B
46	06 12 00.60	+06 46 59.0	29432	6.850	0.125	0.633	0.008	42.55 ± 0.55	5726	4.58	−0.16	2004AJ....128.1177V
47	06 32 37.99	−06 29 18.5	31188	8.622	−0.069	0.560	0.035	16.79 ± 0.91	5789	4.54	−0.59	2006MNRAS.367.1329R
48	06 58 38.54	−00 28 49.7	33582	9.018	−0.017	0.579	0.010	12.56 ± 1.16	5773	4.11	−0.62	2014A&A...562A..71B
49	07 03 30.46	+29 20 13.5	34017	5.930	0.060	0.591	0.003	52.27 ± 0.41	5920	4.42	−0.12	2014A&A...562A..71B
50	07 09 04.96	+15 25 17.7	34511	8.000	0.120	0.620	0.006	21.64 ± 0.79	5789	4.44	−0.11	2014A&A...562A..71B
51	07 15 50.80	−13 02 58.1	35139	7.755	−0.017	0.607	0.002	30.95 ± 0.75	5771	4.47	−0.52	2014A&A...562A..71B
52	07 30 29.02	+18 57 40.6	36491	8.494	−0.117	0.518	0.004	20.20 ± 1.29	5869	4.31	−0.95	2014A&A...562A..71B
53	07 34 35.11	+16 54 04.0	36849	8.950	−0.110	0.510	0.009	12.37 ± 1.23	6012	4.16	−0.84	2014A&A...562A..71B
54	07 40 54.38	−26 21 48.6	37419	8.683	0.070	0.625	0.009	19.16 ± 0.88	5715	4.38	−0.33	2014A&A...562A..71B
55	07 53 33.12	+30 36 18.3	38541	8.300	−0.125	0.619	0.004	34.30 ± 0.90	5316	4.60	−1.84	2014A&A...562A..71B
56	07 56 10.20	+50 32 27.3	38769	8.830	−0.060	0.520	0.016	11.56 ± 0.98	5726	4.15	−0.79	2006MNRAS.367.1329R
57	08 11 38.64	+32 27 25.7	40118	6.827	0.127	0.679	0.003	45.9 ± 0.55	5484	4.58	−0.47	2006MNRAS.367.1329R
58	08 19 22.60	+54 05 10.0	40778	9.741	−0.212	0.480	0.013	10.35 ± 1.56	6006	4.23	−1.55	2010A&A...511L..10N
59	08 27 36.80	+45 39 11.0	41484	6.320	0.120	0.625	0.002	44.94 ± 0.46	5703	4.46	−0.08	2004AJ....128.1177V

Table 1 (*Continued*)

ID	α_{2000} (hh:mm:ss.ss)	δ_{2000} (dd:mm:ss.s)	Hip	V (mag)	$U-B$ (mag)	$B-V$ (mag)	$E_d(B-V)$ (mag)	π (mas)	T_{eff} (K)	$\log g$ (cgs)	[Fe/H] (dex)	Authors
60	08 38 08.51	+26 02 56.3	42356	7.579	0.135	0.632	0.006	22.91 ± 0.59	5962	4.42	0.17	2014A&A...562A..71B
61	08 52 44.51	+22 33 30.2	43595	10.830	−0.040	0.600	0.013	7.87 ± 2.47	5506	4.67	−0.84	2006MNRAS.367.1329R
62	08 54 17.90	−05 26 04.0	43726	6.010	0.212	0.666	0.001	57.52 ± 0.39	5763	4.37	0.01	2004AJ....128.1177V
63	08 59 06.00	−00 37 26.0	44116	8.480	−0.103	0.440	0.008	12.70 ± 1.15	6275	4.10	−0.58	2004AJ....128.1177V
64	09 06 38.83	−43 29 31.1	44713	7.307	0.202	0.666	0.015	26.83 ± 0.51	5823	4.34	0.14	2014A&A...562A..71B
65	09 07 56.60	−50 28 57.0	44811	7.720	−0.040	0.564	0.032	24.53 ± 0.56	5824	4.45	−0.64	2004AJ....128.1177V
66	09 35 16.70	−49 07 48.9	47048	8.550	−0.095	0.398	0.032	10.26 ± 0.95	6630	4.12	−0.50	2014A&A...562A..71B
67	09 36 49.50	+57 54 41.0	47174	9.960	0.030	0.630	0.007	11.99 ± 1.71	5603	4.33	−0.45	2010A&A...511L..10N
68	09 49 42.82	+65 18 15.0	48209	9.696	0.100	0.674	0.031	13.10 ± 1.20	5415	4.64	−0.65	2006MNRAS.367.1329R
69	10 03 37.38	−29 02 36.0	49285	8.110	0.200	0.680	0.012	21.13 ± 1.06	5520	4.29	−0.21	2014A&A...562A..71B
70	10 07 33.80	−06 26 21.0	49615	7.720	−0.060	0.510	0.006	21.25 ± 0.62	6019	4.29	−0.43	2004AJ....128.1177V
71	10 09 49.58	−36 45 14.9	49793	8.082	−0.020	0.596	0.009	22.58 ± 0.69	5764	4.33	−0.63	2014A&A...562A..71B
72	10 11 48.07	+23 45 18.7	49942	8.419	0.115	0.632	0.007	16.86 ± 0.77	5676	4.36	−0.27	2014A&A...562A..71B
73	10 22 46.93	−45 28 14.2	50834	9.320	−0.070	0.438	0.026	8.09 ± 1.12	6552	4.23	−0.27	2014A&A...562A..71B
74	10 24 35.68	−05 31 10.8	50965	9.800	0.000	0.570	0.015	9.14 ± 1.37	5715	4.56	−0.57	2006MNRAS.367.1329R
75	10 46 14.24	−29 20 25.5	52673	9.570	0.030	0.640	0.013	14.07 ± 1.29	5541	4.62	−0.66	2006MNRAS.367.1329R
76	10 47 23.16	+28 23 55.9	52771	10.240	−0.223	0.500	0.012	10.45 ± 1.42	5354	4.77	−1.98	2006MNRAS.367.1329R
77	10 57 09.60	+21 48 17.0	53537	7.940	0.120	0.620	0.004	20.32 ± 0.66	6019	4.43	0.05	2004AJ....128.1177V
78	10 59 28.00	+40 25 49.0	53721	5.030	0.124	0.606	0.001	71.11 ± 0.25	5882	4.34	0.01	2004AJ....128.1177V
79	11 08 40.07	−44 15 33.7	54469	9.814	−0.020	0.563	0.021	9.27 ± 1.29	6098	4.34	−0.43	2014A&A...562A..71B
80	11 11 00.74	−65 25 37.8	54641	8.160	−0.158	0.483	0.025	18.36 ± 0.58	6168	4.29	−1.14	2014A&A...562A..71B
81	11 14 49.93	−23 38 47.9	54924	9.068	0.004	0.584	0.016	15.02 ± 1.09	5682	4.34	−0.80	2014A&A...562A..71B
82	11 23 16.23	+19 53 37.7	55592	9.973	−0.140	0.480	0.010	8.35 ± 1.58	5995	4.14	−1.02	2014A&A...562A..71B
83	11 25 31.80	+42 37 58.0	55761	7.860	−0.040	0.540	0.004	22.95 ± 0.64	5741	4.35	−0.62	2004AJ....128.1177V
84	11 37 08.12	−39 28 12.0	56664	8.717	−0.090	0.438	0.026	9.45 ± 1.07	6364	4.07	−0.68	2014A&A...562A..71B
85	11 41 22.48	−26 40 01.9	57017	7.530	−0.060	0.470	0.007	18.78 ± 0.61	6380	4.35	−0.43	2014A&A...562A..71B
86	11 44 35.70	+25 32 12.0	57265	10.370	−0.131	0.479	0.017	6.25 ± 1.71	5928	4.23	−0.93	2010A&A...511L..10N
87	11 46 31.10	−40 30 01.0	57443	4.890	0.100	0.665	0.003	108.45 ± 0.22	5524	4.29	−0.35	2004AJ....128.1177V
88	11 46 35.15	+50 52 54.7	57450	9.918	−0.150	0.560	0.005	12.85 ± 1.33	5315	4.74	−1.50	2006MNRAS.367.1329R
89	12 04 05.56	+03 20 26.7	58843	9.219	−0.053	0.587	0.008	14.24 ± 1.33	5726	4.41	−0.84	2014A&A...562A..71B

Table 1 (*Continued*)

ID	α_{2000} (hh:mm:ss.ss)	δ_{2000} (dd:mm:ss.s)	Hip	V (mag)	$U-B$ (mag)	$B-V$ (mag)	$E_d(B-V)$ (mag)	π (mas)	T_{eff} (K)	$\log g$ (cgs)	[Fe/H] (dex)	Authors
90	12 05 13.41	−28 43 02.0	58950	7.782	0.140	0.650	0.008	27.85 ± 0.70	5686	4.45	−0.19	2014A&A...562A..71B
91	12 10 57.93	−46 19 19.1	59380	7.524	−0.054	0.561	0.007	27.31 ± 0.65	5901	4.38	−0.58	2014A&A...562A..71B
92	12 30 50.10	+53 04 36.0	61053	6.200	0.015	0.547	0.002	45.92 ± 0.35	6060	4.35	−0.11	2004AJ....128.1177V
93	12 37 39.13	+38 41 03.7	61619	7.350	−0.020	0.480	0.004	17.81 ± 0.46	6429	4.26	0.04	2014A&A...562A..71B
94	12 43 43.22	−44 40 31.6	62108	9.909	−0.160	0.463	0.022	8.17 ± 1.43	6293	4.37	−1.53	2014A&A...562A..71B
95	12 44 59.40	+39 16 44.0	62207	5.950	−0.044	0.548	0.002	57.55 ± 0.32	5795	4.15	−0.59	2004AJ....128.1177V
96	12 52 11.64	−56 34 28.0	62809	8.477	−0.020	0.613	0.017	20.67 ± 1.04	5658	4.38	−0.77	2014A&A...562A..71B
97	13 11 21.40	+09 37 33.5	64345	8.743	0.053	0.621	0.008	16.88 ± 1.04	5598	4.37	−0.60	2014A&A...562A..71B
98	13 11 52.40	+27 52 41.0	64394	4.230	0.068	0.571	0.001	109.54 ± 0.17	6029	4.38	0.03	2004AJ....128.1177V
99	13 15 36.97	+09 00 57.7	64698	8.450	0.170	0.660	0.008	18.48 ± 1.10	5624	4.35	−0.13	2014A&A...562A..71B
100	13 16 11.25	+35 53 09.1	64747	8.280	0.120	0.640	0.003	21.87 ± 0.8	5718	4.47	−0.21	2014A&A...562A..71B
101	13 24 30.60	+20 27 22.0	65418	12.190	−0.174	0.450	0.017	3.12 ± 3.30	6043	4.18	−1.56	2010A&A...511L..10N
102	13 34 32.65	−38 54 26.0	66238	7.294	0.121	0.670	0.005	33.27 ± 0.61	5660	4.42	−0.22	2014A&A...562A..71B
103	13 51 40.40	−57 26 08.0	67655	7.970	0.005	0.662	0.009	39.42 ± 0.97	5396	4.38	−0.93	2004AJ....128.1177V
104	13 53 58.12	−46 32 19.5	67863	9.038	−0.047	0.604	0.011	16.70 ± 1.24	5692	4.35	−0.76	2014A&A...562A..71B
105	13 55 50.00	+14 03 23.0	68030	6.160	−0.085	0.501	0.003	40.22 ± 0.37	6081	4.40	−0.38	2004AJ....128.1177V
106	14 23 15.30	+01 14 30.0	70319	6.250	0.083	0.637	0.003	58.17 ± 0.53	5597	4.44	−0.41	2004AJ....128.1177V
107	14 27 24.91	−18 24 40.4	70681	9.302	−0.103	0.597	0.014	21.04 ± 1.12	5484	4.48	−1.30	2014A&A...562A..71B
108	14 29 03.26	−46 44 28.0	70829	8.937	0.092	0.684	0.011	19.18 ± 1.21	5471	4.47	−0.67	2014A&A...562A..71B
109	14 32 04.50	+18 50 10.0	71076	7.810	−0.080	0.500	0.007	17.24 ± 0.75	6038	4.22	−0.39	2004AJ....128.1177V
110	14 40 28.26	−57 01 46.4	71735	7.385	0.150	0.670	0.012	37.71 ± 0.72	5513	4.43	−0.35	2014A&A...562A..71B
111	14 48 18.70	+58 54 36.1	72407	9.760	0.073	0.620	0.003	10.65 ± 0.73	5567	4.56	−0.54	2006MNRAS.367.1329R
112	14 51 31.72	−60 55 50.8	72673	7.176	−0.103	0.450	0.019	20.06 ± 0.71	6374	4.29	−0.56	2014A&A...562A..71B
113	15 08 12.57	−07 54 47.5	74067	8.000	−0.050	0.590	0.010	26.62 ± 0.86	5695	4.38	−0.81	2014A&A...562A..71B
114	15 21 48.15	−48 19 03.5	75181	5.651	0.069	0.639	0.004	67.51 ± 0.39	5698	4.46	−0.32	2014A&A...562A..71B
115	16 03 13.30	+42 14 46.6	78640	9.854	−0.198	0.474	0.006	8.41 ± 1.02	6069	4.30	−1.43	2014A&A...562A..71B
116	16 39 04.14	−58 15 29.5	81520	7.021	0.029	0.615	0.006	44.54 ± 0.54	5746	4.62	−0.44	2014A&A...562A..71B
117	16 41 08.21	−02 51 26.2	81681	7.245	0.070	0.631	0.027	33.82 ± 0.58	5565	4.52	−0.38	2006MNRAS.367.1329R
118	17 00 31.65	−57 17 49.6	83229	7.006	−0.020	0.574	0.006	32.77 ± 0.63	5865	4.41	−0.49	2014A&A...562A..71B
119	17 03 49.15	+17 11 21.1	83489	9.128	0.100	0.651	0.016	13.43 ± 1.41	5722	4.28	−0.29	2014A&A...562A..71B

Table 1 (*Continued*)

ID	α_{2000} (hh:mm:ss.ss)	δ_{2000} (dd:mm:ss.s)	Hip	V (mag)	$U-B$ (mag)	$B-V$ (mag)	$E_d(B-V)$ (mag)	π (mas)	T_{eff} (K)	$\log g$ (cgs)	[Fe/H] (dex)	Authors
120	17 22 12.65	−75 20 53.3	84988	6.996	−0.012	0.599	0.006	35.67 ± 0.50	5686	4.25	−0.70	2014A&A...562A..71B
121	17 22 27.65	+24 52 46.0	85007	6.870	−0.064	0.511	0.006	34.12 ± 0.57	6064	4.32	−0.39	2014A&A...562A..71B
122	17 22 51.29	−02 23 17.4	85042	6.282	0.235	0.680	0.021	51.22 ± 0.40	5648	4.46	0.00	2014A&A...562A..71B
123	17 34 43.06	+06 00 51.6	86013	8.390	−0.050	0.570	0.012	19.38 ± 1.14	5760	4.30	−0.81	2014A&A...562A..71B
124	17 38 15.61	+18 33 25.5	86321	9.781	−0.104	0.484	0.019	8.38 ± 1.29	5760	4.59	−0.87	2006MNRAS.367.1329R
125	17 47 28.00	−08 46 48.0	87062	10.593	−0.133	0.590	0.105	9.59 ± 2.21	6027	4.32	−1.49	2010A&A...511L..10N
126	18 09 21.38	+29 57 06.2	88945	6.850	0.090	0.620	0.004	40.29 ± 0.49	5869	4.62	0.02	2014A&A...562A..71B
127	18 48 16.40	+23 30 53.1	92270	6.120	0.020	0.501	0.007	34.78 ± 0.41	6376	4.23	−0.05	2014A&A...562A..71B
128	18 51 25.20	+38 37 36.0	92532	7.150	−0.045	0.540	0.004	32.72 ± 0.36	5825	4.30	−0.56	2004AJ....128.1177V
129	18 54 23.20	−04 36 18.6	92781	9.071	−0.050	0.584	0.023	14.59 ± 1.29	5765	4.33	−0.69	2014A&A...562A..71B
130	18 58 51.00	+30 10 50.3	93185	6.790	0.000	0.580	0.005	41.94 ± 0.47	5864	4.54	−0.29	2014A&A...562A..71B
131	19 09 39.24	−21 28 10.8	94129	8.210	0.130	0.630	0.013	17.6 ± 0.76	5630	4.35	−0.27	2006MNRAS.367.1329R
132	19 15 33.23	−24 10 45.7	94645	6.254	0.070	0.540	0.007	36.30 ± 0.70	6365	4.56	0.24	2014A&A...562A..71B
133	19 32 40.33	−28 01 11.3	96124	7.151	0.155	0.671	0.007	36.72 ± 0.95	5577	4.47	−0.22	2014A&A...562A..71B
134	19 34 19.79	+51 14 11.8	96258	5.733	−0.009	0.468	0.004	39.82 ± 0.2	6380	4.15	−0.03	2014A&A...562A..71B
135	19 58 58.54	−46 05 17.0	98355	7.473	−0.086	0.477	0.009	19.11 ± 0.84	6232	4.18	−0.62	2014A&A...562A..71B
136	20 07 36.91	−41 01 09.6	99139	8.840	0.100	0.640	0.010	17.95 ± 1.16	5612	4.32	−0.37	2014A&A...562A..71B
137	20 16 38.08	−07 26 37.8	99938	8.389	−0.024	0.575	0.009	17.64 ± 0.82	5732	4.48	−0.54	2006MNRAS.367.1329R
138	20 17 31.30	+66 51 13.0	100017	5.910	0.058	0.585	0.018	56.92 ± 0.24	5782	4.44	−0.19	2004AJ....128.1177V
139	20 20 24.60	+06 01 53.0	100279	10.134	−0.048	0.614	0.031	10.46 ± 1.60	5673	4.31	−0.72	2010A&A...511L..10N
140	20 23 35.85	−21 22 14.2	100568	8.653	−0.133	0.549	0.008	22.78 ± 1.00	5800	4.48	−1.10	2014A&A...562A..71B
141	20 26 11.92	+09 27 00.4	100792	8.344	−0.174	0.483	0.011	17.00 ± 0.83	6002	4.31	−1.11	2014A&A...562A..71B
142	20 40 22.33	−24 07 04.9	102018	7.212	0.143	0.602	0.008	24.89 ± 0.57	5933	4.12	0.13	2014A&A...562A..71B
143	20 40 49.38	−18 47 33.3	102046	8.232	−0.131	0.495	0.009	16.15 ± 0.93	6009	4.13	−1.05	2014A&A...562A..71B
144	20 49 15.19	−20 37 50.8	102762	8.126	0.080	0.593	0.018	17.11 ± 0.88	5948	4.30	−0.04	2014A&A...562A..71B
145	20 49 37.80	+12 32 42.0	102805	6.010	−0.090	0.420	0.006	32.66 ± 0.41	6337	4.31	−0.32	2004AJ....128.1177V
146	20 57 40.07	−44 07 45.7	103458	6.519	−0.042	0.586	0.004	45.17 ± 0.46	5843	4.53	−0.61	2014A&A...562A..71B
147	20 58 08.52	−48 12 13.5	103498	8.290	−0.130	0.520	0.006	18.95 ± 0.76	5856	4.23	−1.11	2014A&A...562A..71B
148	21 03 06.10	+29 28 56.0	103897	10.190	0.030	0.610	0.034	7.70 ± 1.63	5607	4.39	−0.67	2010A&A...511L..10N
149	21 11 59.03	+17 43 39.9	104659	7.371	−0.158	0.511	0.009	29.10 ± 0.64	5973	4.35	−1.08	2014A&A...562A..71B

Table 1 (*Continued*)

ID	α_{2000} (hh:mm:ss.ss)	δ_{2000} (dd:mm:ss.s)	Hip	V (mag)	$U-B$ (mag)	$B-V$ (mag)	$E_d(B-V)$ (mag)	π (mas)	T_{eff} (K)	$\log g$ (cgs)	[Fe/H] (dex)	Authors
150	21 43 57.12	+27 23 24.0	107294	10.050	−0.140	0.480	0.018	9.03 ± 1.68	5929	4.63	−1.14	2006MNRAS.367.1329R
151	21 51 24.61	−23 16 14.2	107877	6.872	−0.044	0.484	0.007	24.91 ± 0.56	6355	4.20	−0.24	2014A&A...562A..71B
152	21 58 24.32	−12 39 52.8	108468	7.210	0.115	0.625	0.007	29.93 ± 0.74	5799	4.25	−0.08	2014A&A...562A..71B
153	22 01 36.52	−53 05 36.9	108736	7.100	0.025	0.569	0.004	27.95 ± 0.55	5990	4.47	−0.29	2014A&A...562A..71B
154	22 06 33.17	+01 51 25.7	109144	7.244	0.020	0.524	0.009	19.52 ± 0.77	6272	4.21	−0.08	2014A&A...562A..71B
155	22 09 34.61	−41 13 29.6	109381	7.837	0.210	0.660	0.003	23.53 ± 0.76	5803	4.46	0.13	2014A&A...562A..71B
156	22 12 43.50	−06 28 08.0	109646	7.440	−0.080	0.520	0.010	27.64 ± 0.68	5910	4.25	−0.64	2004AJ....128.1177V
157	22 17 15.14	+12 53 54.6	110035	7.041	0.076	0.600	0.010	32.22 ± 0.52	5907	4.42	−0.14	2014A&A...562A..71B
158	22 20 55.80	+08 11 12.3	110341	6.178	−0.052	0.450	0.010	32.33 ± 0.55	6577	4.35	−0.09	2014A&A...562A..71B
159	22 23 49.10	+24 23 33.0	110560	10.640	0.009	0.571	0.031	5.32 ± 1.65	5791	4.14	−0.53	2010A&A...511L..10N
160	22 36 07.70	−54 36 38.2	111565	7.580	0.100	0.665	0.003	31.82 ± 0.63	5534	4.44	−0.48	2014A&A...562A..71B
161	22 50 45.94	+01 51 54.6	112811	9.338	0.082	0.682	0.018	16.56 ± 1.22	5347	4.64	−0.70	2006MNRAS.367.1329R
162	23 01 33.17	+19 16 10.7	113688	8.670	0.090	0.610	0.024	12.07 ± 0.88	5757	4.29	−0.14	2014A&A...562A..71B
163	23 03 57.30	−04 47 42.0	113896	6.680	0.052	0.580	0.007	34.03 ± 0.77	5872	4.28	−0.18	2004AJ....128.1177V
164	23 10 43.49	+18 54 32.6	114450	8.560	0.055	0.595	0.043	14.48 ± 1.09	5935	4.40	−0.05	2014A&A...562A..71B
165	23 14 07.47	−08 55 27.6	114702	7.554	−0.037	0.554	0.008	25.6 ± 1.26	6028	4.33	−0.34	2014A&A...562A..71B
166	23 16 42.30	+53 12 49.0	114924	5.580	0.011	0.524	0.005	48.77 ± 0.26	6134	4.21	0.00	2004AJ....128.1177V
167	23 31 31.50	−04 05 15.0	116106	6.500	−0.026	0.527	0.007	38.29 ± 0.54	6005	4.42	−0.24	2004AJ....128.1177V
168	23 57 33.52	−09 38 51.1	118115	7.863	0.146	0.641	0.010	20.84 ± 0.87	5833	4.39	0.02	2014A&A...562A..71B

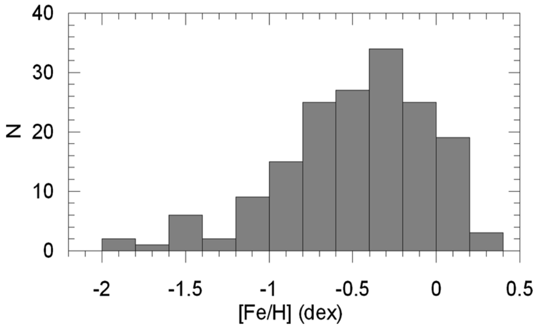

Fig. 1 Metallicity distribution of the sample stars

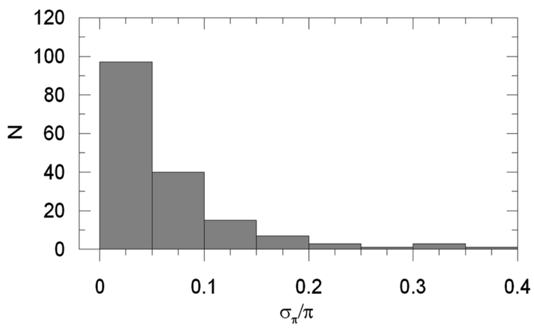

Fig. 2 Distribution of the relative parallax errors for the sample stars

they were fitted to fifth degree polynomial equations as follows:

$$\begin{aligned}(U-B)_0 = {} & 2.791(0.702) - 20.567(5.558) \times (B-V)_0 \\ & + 58.355(16.920) \times (B-V)_0^2 \\ & - 81.837(24.836) \times (B-V)_0^3 \\ & + 59.22(17.631) \times (B-V)_0^4 \\ & - 17.115(4.857) \times (B-V)_0^5. \qquad (7)\end{aligned}$$

and

$$\begin{aligned}M_V = {} & 5.661(3.185) - 36.582(22.392) \times (B-V)_0 \\ & + 133.228(58.043) \times (B-V)_0^2 \\ & - 188.632(72.402) \times (B-V)_0^3 \\ & + 122.703(43.577) \times (B-V)_0^4 \\ & - 29.961(10.156) \times (B-V)_0^5. \qquad (8)\end{aligned}$$

The numbers in parenthesis indicate the error values of the related coefficients. The correlation coefficient and standard deviation of Eq. (7) and Eq. (8) are $R^2 = 0.999$ and $\sigma = 0.007$ mag and $R^2 = 0.989$ and $\sigma = 0.164$ mag, respectively.

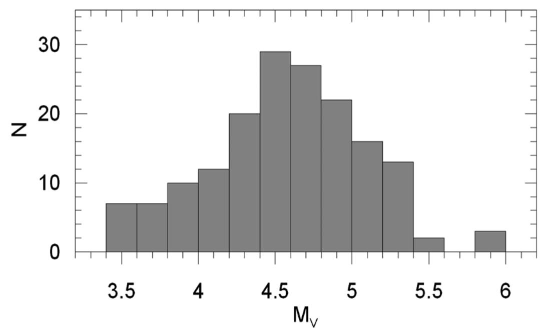

Fig. 3 Absolute magnitude distribution for the sample stars

3 Procedure

3.1 Metallicity calibration

We used the same procedure in Karaali et al. (2005) and Karataş and Schuster (2006) for the metallicity calibration. However, our data are different than the cited studies. As stated in Sect. 2, our metallicities (the iron abundances) are provided from recent studies (Bensby et al. 2014; Nissen and Schuster 2010; Reddy et al. 2006; Venn et al. 2004). Hence, we expect more accurate iron abundances. The same case holds for the absolute magnitudes and distances which are estimated via the re-reduced *Hipparcos* parallaxes (van Leeuwen 2007) and hence they are more accurate than the ones published formerly (ESA 1997). We fitted the guillotine factors of Sandage (1969) in sixteen $B-V$ colours to a sixth degree polynomial as in the following which could be used to evaluate a guillotine factor (normalized factor) for each $B-V$ colour:

$$\begin{aligned}f = \delta(U-B)_{0.6}/\delta(U-B) = {} & 8.175 - 83.963 \times (B-V)_0 \\ & + 409.970 \times (B-V)_0^2 - 1018.242 \times (B-V)_0^3 \\ & + 1341.239 \times (B-V)_0^4 - 889.844 \times (B-V)_0^5 \\ & + 234.468 \times (B-V)_0^6. \qquad (9)\end{aligned}$$

Data used for the metallicity calibration are given in Table 2. We fitted the iron abundances (Table 1) in terms of normalized UV excesses to a third degree polynomial as follows and presented in Fig. 4:

$$\begin{aligned}[\mathrm{Fe/H}] = {} & 0.105(0.010) - 5.428(0.521) \times \delta_{0.6} \\ & + 7.340(5.895) \times \delta_{0.6}^2 \\ & - 50.081(16.359) \times \delta_{0.6}^3, \qquad (10)\end{aligned}$$

where $\delta_{0.6}$ indicates $\delta_{0.6}(U-B)$. The correlation coefficient and standard deviation of Eq. (10) are $R^2 = 0.949$ and $\sigma = 0.134$ dex, respectively.

We estimated the iron abundances of the sample stars, $[\mathrm{Fe/H}]_{est}$, using Eq. (10) and compared them with the original ones (Fig. 5). There is a linear relation between two sets

Table 2 Data used in the calibrations. The columns give: ID, Hipparcos number, de-reddened apparent magnitude V_0 and $(B-V)_0$, $(U-B)_0$ colours, $(U-B)_{Hya}$ colour for the Hyades cluster, UV excess $\delta(U-B)$, normalized factor f, normalized UV excess $\delta_{0.6}$, original absolute magnitude $(M_V)_{org}$, absolute magnitude for the Hyades cluster $(M_V)_{Hya}$, absolute magnitude offset ΔM_V, estimated absolute magnitude $(M_V)_{est}$, and absolute magnitude residuals $(M_V)_{res}$

ID	Hip	V_0	$(B-V)_0$	$(U-B)_0$	$(U-B)_{Hya}$	δ	f	$\delta_{0.60}$	[Fe/H]$_{cal}$	[Fe/H]$_{res}$	$(M_V)_{org}$	$(M_V)_{Hya}$	ΔM_V	$(M_V)_{est}$	$(M_V)_{res}$
1	493	7.435	0.555	0.036	0.078	0.042	1.035	0.043	−0.12	0.17	4.586	4.212	0.374	4.260	0.326
2	910	4.886	0.489	−0.016	0.026	0.042	1.102	0.046	−0.14	0.19	3.521	3.751	−0.230	3.813	−0.292
3	1599	4.225	0.571	0.017	0.094	0.077	1.025	0.079	−0.30	−0.11	4.556	4.318	0.238	4.542	0.014
4	1976	7.548	0.611	0.152	0.139	−0.013	1.015	−0.013	0.18	−0.01	4.187	4.569	−0.382	4.325	−0.138
5	2711	5.563	0.464	−0.017	0.013	0.030	1.132	0.034	−0.07	−0.13	3.532	3.570	−0.038	3.570	−0.038
6	3182	8.695	0.627	0.084	0.158	0.074	1.019	0.075	−0.28	0.01	4.816	4.664	0.152	4.870	−0.054
7	3479	7.777	0.663	0.155	0.206	0.051	1.042	0.053	−0.17	0.09	5.226	4.867	0.359	4.963	0.263
8	3497	6.538	0.652	0.106	0.191	0.085	1.033	0.088	−0.35	−0.03	4.820	4.806	0.014	5.074	−0.254
9	3704	7.819	0.536	−0.044	0.061	0.105	1.050	0.110	−0.47	−0.12	4.379	4.084	0.295	4.466	−0.087
10	3909	5.178	0.507	−0.005	0.038	0.043	1.081	0.046	−0.14	−0.11	4.191	3.881	0.310	3.944	0.247
11	4544	9.630	0.492	−0.135	0.028	0.163	1.098	0.179	−0.92	−0.05	4.456	3.773	0.683	4.538	−0.082
12	4892	8.501	0.575	0.004	0.098	0.094	1.023	0.096	−0.39	−0.10	4.586	4.344	0.242	4.654	−0.068
13	5163	9.416	0.584	−0.007	0.108	0.115	1.019	0.117	−0.51	0.23	4.591	4.402	0.189	4.820	−0.229
14	5301	8.384	0.632	0.157	0.164	0.007	1.021	0.007	0.07	0.18	4.688	4.693	−0.005	4.557	0.131
15	5862	4.954	0.570	0.097	0.093	−0.004	1.025	−0.004	0.13	−0.04	4.057	4.311	−0.254	4.115	−0.058
16	6159	8.862	0.583	−0.027	0.107	0.134	1.019	0.137	−0.63	0.04	4.793	4.395	0.398	4.916	−0.123
17	7217	8.960	0.598	0.043	0.123	0.080	1.016	0.081	−0.31	0.17	4.782	4.490	0.292	4.726	0.056
18	7459	10.070	0.520	−0.167	0.048	0.215	1.066	0.229	−1.36	−0.13	5.251	3.972	1.279	5.073	0.178
19	7978	5.531	0.527	−0.006	0.053	0.059	1.059	0.062	−0.22	−0.27	4.324	4.021	0.303	4.163	0.161
20	8859	6.730	0.444	−0.062	0.006	0.068	1.156	0.079	−0.30	0.00	3.642	3.423	0.219	3.645	−0.003
21	9085	6.088	0.477	−0.062	0.019	0.081	1.116	0.090	−0.36	−0.10	3.942	3.664	0.278	3.945	−0.003
22	10449	9.055	0.571	−0.077	0.094	0.171	1.025	0.175	−0.89	−0.02	5.058	4.318	0.740	5.060	−0.002
23	10652	8.954	0.592	−0.008	0.117	0.125	1.017	0.127	−0.57	0.10	4.965	4.452	0.513	4.922	0.043
24	12294	10.470	0.443	−0.171	0.006	0.177	1.157	0.205	−1.13	−0.18	4.295	3.416	0.879	4.346	−0.051
25	12306	7.306	0.569	−0.015	0.092	0.107	1.026	0.110	−0.47	0.05	4.631	4.305	0.326	4.685	−0.054
26	12444	5.766	0.517	−0.013	0.045	0.058	1.070	0.062	−0.22	−0.31	4.078	3.951	0.127	4.091	−0.013
27	12653	5.394	0.553	0.073	0.076	0.003	1.036	0.003	0.09	−0.18	4.220	4.199	0.021	4.042	0.178
28	12777	4.090	0.482	−0.009	0.022	0.031	1.110	0.034	−0.08	−0.06	3.858	3.701	0.157	3.704	0.154
29	12889	7.625	0.576	0.043	0.099	0.056	1.022	0.057	−0.19	−0.06	4.147	4.350	−0.203	4.466	−0.319
30	13366	8.234	0.499	−0.096	0.032	0.128	1.090	0.140	−0.65	0.04	4.307	3.823	0.484	4.360	−0.053
31	14241	8.048	0.658	0.108	0.199	0.091	1.038	0.094	−0.38	0.07	5.325	4.840	0.485	5.142	0.183
32	15131	6.748	0.576	−0.023	0.099	0.122	1.022	0.125	−0.55	−0.12	4.830	4.350	0.480	4.807	0.023
33	15158	8.460	0.501	0.009	0.034	0.025	1.088	0.027	−0.04	0.02	3.576	3.838	−0.262	3.804	−0.228

Table 2 (*Continued*)

ID	Hip	V_0	$(B-V)_0$	$(U-B)_0$	$(U-B)_{Hya}$	δ	f	$\delta_{0.60}$	$[Fe/H]_{cal}$	$[Fe/H]_{res}$	$(M_V)_{org}$	$(M_V)_{Hya}$	ΔM_V	$(M_V)_{est}$	$(M_V)_{res}$
34	15381	7.472	0.598	0.154	0.123	−0.031	1.016	−0.031	0.28	0.20	3.994	4.490	−0.496	4.144	−0.150
35	16169	8.210	0.612	0.022	0.140	0.118	1.015	0.120	−0.53	0.04	4.860	4.575	0.285	5.006	−0.146
36	17147	6.664	0.532	−0.092	0.057	0.149	1.054	0.157	−0.76	0.05	4.626	4.056	0.570	4.691	−0.065
37	22632	9.106	0.481	−0.196	0.021	0.217	1.111	0.241	−1.48	0.14	4.986	3.694	1.292	4.884	0.102
38	23555	6.296	0.528	0.039	0.054	0.015	1.058	0.016	0.02	−0.20	3.788	4.028	−0.240	3.937	−0.149
39	23688	9.647	0.416	−0.163	0.003	0.166	1.186	0.197	−1.06	−0.17	4.367	3.220	1.147	4.097	0.270
40	24030	9.648	0.497	−0.147	0.031	0.178	1.092	0.194	−1.04	−0.04	4.336	3.809	0.527	4.670	−0.334
41	25860	8.506	0.627	0.088	0.158	0.070	1.019	0.071	−0.26	0.09	5.019	4.664	0.355	4.850	0.169
42	26617	10.116	0.554	−0.025	0.077	0.102	1.035	0.106	−0.45	0.30	4.836	4.206	0.630	4.564	0.272
43	27072	3.587	0.480	−0.008	0.021	0.029	1.113	0.032	−0.06	−0.04	3.833	3.686	0.147	3.678	0.155
44	28403	8.575	0.620	0.046	0.149	0.103	1.017	0.105	−0.44	−0.11	5.041	4.623	0.418	4.977	0.064
45	28671	9.260	0.602	−0.055	0.128	0.183	1.015	0.186	−0.97	0.14	5.388	4.514	0.874	5.320	0.068
46	29432	6.826	0.625	0.119	0.156	0.037	1.018	0.038	−0.09	0.07	4.970	4.652	0.318	4.671	0.299
47	31188	8.514	0.525	−0.094	0.052	0.146	1.061	0.155	−0.75	−0.16	4.639	4.007	0.632	4.630	0.009
48	33582	8.987	0.569	−0.024	0.092	0.116	1.026	0.119	−0.52	0.10	4.482	4.305	0.177	4.732	−0.250
49	34017	5.921	0.588	0.058	0.112	0.054	1.018	0.055	−0.18	−0.06	4.512	4.427	0.085	4.532	−0.020
50	34511	7.981	0.614	0.116	0.142	0.026	1.016	0.026	−0.03	0.08	4.657	4.587	0.070	4.549	0.108
51	35139	7.749	0.605	−0.018	0.131	0.149	1.015	0.151	−0.72	−0.20	5.202	4.533	0.669	5.135	0.067
52	36491	8.482	0.514	−0.120	0.043	0.163	1.073	0.175	−0.89	0.06	5.009	3.930	1.079	4.670	0.339
53	36849	8.922	0.501	−0.116	0.034	0.150	1.088	0.163	−0.80	0.04	4.384	3.838	0.546	4.508	−0.124
54	37419	8.655	0.616	0.064	0.145	0.081	1.016	0.082	−0.32	0.01	5.067	4.599	0.468	4.840	0.227
55	38541	8.288	0.615	−0.128	0.143	0.271	1.016	0.275	−1.88	−0.04	5.964	4.593	1.371	6.066	−0.102
56	38769	8.780	0.504	−0.072	0.036	0.108	1.084	0.117	−0.51	0.28	4.095	3.859	0.236	4.276	−0.181
57	40118	6.817	0.676	0.125	0.224	0.099	1.056	0.105	−0.44	0.03	5.126	4.936	0.190	5.289	−0.163
58	40778	9.699	0.467	−0.222	0.014	0.236	1.129	0.266	−1.77	−0.22	4.774	3.592	1.182	4.987	−0.213
59	41484	6.312	0.623	0.118	0.153	0.035	1.017	0.036	−0.08	0.00	4.575	4.641	−0.066	4.650	−0.075
60	42356	7.560	0.626	0.131	0.157	0.026	1.018	0.026	−0.03	−0.20	4.360	4.658	−0.298	4.621	−0.261
61	43595	10.789	0.587	−0.049	0.111	0.160	1.018	0.163	−0.80	0.04	5.269	4.421	0.848	5.089	0.180
62	43726	6.007	0.665	0.211	0.209	−0.002	1.044	−0.002	0.12	0.11	4.806	4.878	−0.072	4.693	0.113
63	44116	8.456	0.432	−0.109	0.004	0.113	1.169	0.132	−0.60	−0.02	3.975	3.336	0.639	3.833	0.142
64	44713	7.261	0.651	0.191	0.189	−0.002	1.032	−0.002	0.12	−0.02	4.404	4.801	−0.397	4.616	−0.212
65	44811	7.622	0.532	−0.063	0.057	0.120	1.054	0.126	−0.57	0.07	4.570	4.056	0.514	4.523	0.047
66	47048	8.451	0.366	−0.118	0.018	0.136	1.227	0.167	−0.83	−0.33	3.507	2.875	0.632	3.567	−0.060
67	47174	9.940	0.623	0.025	0.153	0.128	1.017	0.130	−0.59	−0.14	5.334	4.641	0.693	5.127	0.207

Table 2 (*Continued*)

ID	Hip	V_0	$(B-V)_0$	$(U-B)_0$	$(U-B)_{Hya}$	δ	f	$\delta_{0.60}$	$[Fe/H]_{cal}$	$[Fe/H]_{res}$	$(M_V)_{org}$	$(M_V)_{Hya}$	ΔM_V	$(M_V)_{est}$	$(M_V)_{res}$
68	48209	9.601	0.643	0.078	0.179	0.101	1.027	0.104	−0.43	0.22	5.187	4.756	0.431	5.104	0.083
69	49285	8.073	0.668	0.191	0.213	0.022	1.047	0.023	−0.02	0.19	4.697	4.894	−0.197	4.839	−0.142
70	49615	7.703	0.504	−0.064	0.036	0.100	1.084	0.108	−0.46	−0.03	4.340	3.859	0.481	4.231	0.109
71	49793	8.054	0.587	−0.026	0.111	0.137	1.018	0.139	−0.65	−0.02	4.823	4.421	0.402	4.958	−0.135
72	49942	8.397	0.625	0.110	0.156	0.046	1.018	0.047	−0.14	0.13	4.531	4.652	−0.121	4.717	−0.186
73	50834	9.239	0.412	−0.089	0.003	0.092	1.190	0.109	−0.47	−0.20	3.779	3.192	0.587	3.570	0.209
74	50965	9.753	0.555	−0.011	0.078	0.089	1.035	0.092	−0.37	0.20	4.558	4.212	0.346	4.502	0.056
75	52673	9.531	0.627	0.021	0.158	0.137	1.019	0.140	−0.65	0.01	5.272	4.664	0.608	5.201	0.071
76	52771	10.203	0.488	−0.232	0.025	0.257	1.103	0.283	−1.98	0.00	5.299	3.744	1.555	5.290	0.009
77	53537	7.928	0.616	0.117	0.145	0.028	1.016	0.028	−0.04	−0.09	4.468	4.599	−0.131	4.572	−0.104
78	53721	5.027	0.605	0.123	0.131	0.008	1.015	0.008	0.06	0.05	4.287	4.533	−0.246	4.402	−0.115
79	54469	9.749	0.542	−0.035	0.066	0.101	1.045	0.106	−0.45	−0.02	4.584	4.125	0.459	4.483	0.101
80	54641	8.083	0.458	−0.176	0.011	0.187	1.139	0.213	−1.20	−0.06	4.402	3.526	0.876	4.511	−0.109
81	54924	9.018	0.568	−0.008	0.091	0.099	1.026	0.102	−0.42	0.38	4.901	4.298	0.603	4.636	0.265
82	55592	9.942	0.470	−0.147	0.016	0.163	1.125	0.183	−0.95	0.07	4.550	3.613	0.937	4.405	0.145
83	55761	7.847	0.536	−0.043	0.061	0.104	1.050	0.109	−0.47	0.15	4.651	4.084	0.567	4.461	0.190
84	56664	8.636	0.412	−0.109	0.003	0.112	1.190	0.133	−0.61	0.07	3.513	3.192	0.321	3.695	−0.182
85	57017	7.508	0.463	−0.065	0.013	0.078	1.133	0.088	−0.35	0.08	3.876	3.562	0.314	3.833	0.043
86	57265	10.318	0.462	−0.143	0.012	0.155	1.135	0.176	−0.90	0.03	4.297	3.555	0.742	4.301	−0.004
87	57443	4.879	0.662	0.098	0.204	0.106	1.042	0.110	−0.47	−0.12	5.055	4.861	0.194	5.244	−0.189
88	57450	9.902	0.555	−0.154	0.078	0.232	1.035	0.240	−1.47	0.03	5.447	4.212	1.235	5.395	0.052
89	58843	9.194	0.579	−0.059	0.102	0.161	1.021	0.164	−0.81	0.03	4.962	4.370	0.592	5.047	−0.085
90	58950	7.757	0.642	0.134	0.177	0.043	1.026	0.044	−0.12	0.07	4.981	4.750	0.231	4.801	0.180
91	59380	7.502	0.554	−0.059	0.077	0.136	1.035	0.141	−0.65	−0.07	4.684	4.206	0.478	4.750	−0.066
92	61053	6.193	0.545	0.013	0.069	0.056	1.042	0.058	−0.20	−0.09	4.503	4.145	0.358	4.267	0.236
93	61619	7.338	0.476	−0.023	0.019	0.042	1.118	0.047	−0.14	−0.18	3.591	3.657	−0.066	3.722	−0.131
94	62108	9.841	0.441	−0.176	0.005	0.181	1.159	0.210	−1.17	0.36	4.402	3.402	1.000	4.365	0.037
95	62207	5.945	0.546	−0.045	0.070	0.115	1.042	0.120	−0.53	0.06	4.745	4.152	0.593	4.584	0.161
96	62809	8.424	0.596	−0.032	0.121	0.153	1.016	0.155	−0.75	0.02	5.001	4.477	0.524	5.103	−0.102
97	64345	8.718	0.613	0.047	0.141	0.094	1.015	0.095	−0.39	0.21	4.855	4.581	0.274	4.887	−0.032
98	64394	4.228	0.570	0.067	0.093	0.026	1.025	0.027	−0.04	−0.07	4.426	4.311	0.115	4.275	0.151
99	64698	8.425	0.652	0.164	0.191	0.027	1.033	0.028	−0.04	0.09	4.759	4.806	−0.047	4.776	−0.017
100	64747	8.271	0.637	0.118	0.171	0.053	1.023	0.054	−0.18	0.03	4.970	4.722	0.248	4.823	0.147
101	65418	12.138	0.433	−0.186	0.004	0.190	1.168	0.222	−1.29	0.27	4.609	3.343	1.266	4.391	0.218

Table 2 (*Continued*)

ID	Hip	V_0	$(B-V)_0$	$(U-B)_0$	$(U-B)_{Hya}$	δ	f	$\delta_{0.60}$	$[Fe/H]_{cal}$	$[Fe/H]_{res}$	$(M_V)_{org}$	$(M_V)_{Hya}$	ΔM_V	$(M_V)_{est}$	$(M_V)_{res}$
102	66238	7.279	0.665	0.117	0.209	0.092	1.044	0.096	−0.39	−0.17	4.889	4.878	0.011	5.188	−0.299
103	67655	7.941	0.653	−0.002	0.192	0.194	1.034	0.201	−1.09	−0.16	5.920	4.812	1.108	5.714	0.206
104	67863	9.004	0.593	−0.055	0.118	0.173	1.016	0.176	−0.89	−0.13	5.118	4.458	0.660	5.203	−0.085
105	68030	6.151	0.498	−0.087	0.032	0.119	1.091	0.130	−0.59	−0.21	4.173	3.816	0.357	4.301	−0.128
106	70319	6.242	0.634	0.081	0.167	0.086	1.022	0.088	−0.35	0.06	5.065	4.705	0.360	4.974	0.091
107	70681	9.259	0.583	−0.113	0.107	0.220	1.019	0.224	−1.31	−0.01	5.874	4.395	1.479	5.459	0.415
108	70829	8.903	0.673	0.084	0.220	0.136	1.053	0.143	−0.67	0.00	5.317	4.921	0.396	5.478	−0.161
109	71076	7.787	0.493	−0.085	0.028	0.113	1.097	0.124	−0.55	−0.16	3.970	3.780	0.190	4.233	−0.263
110	71735	7.348	0.658	0.141	0.199	0.058	1.038	0.060	−0.21	0.14	5.230	4.840	0.390	4.971	0.259
111	72407	9.750	0.617	0.071	0.146	0.075	1.016	0.076	−0.29	0.25	4.887	4.605	0.282	4.815	0.072
112	72673	7.117	0.431	−0.117	0.003	0.120	1.171	0.141	−0.65	−0.09	3.629	3.329	0.300	3.871	−0.242
113	74067	7.969	0.580	−0.057	0.103	0.160	1.020	0.163	−0.80	0.01	5.095	4.376	0.719	5.046	0.049
114	75181	5.639	0.635	0.066	0.168	0.102	1.022	0.104	−0.44	−0.12	4.786	4.710	0.076	5.061	−0.275
115	78640	9.835	0.468	−0.202	0.015	0.217	1.127	0.245	−1.52	−0.09	4.459	3.599	0.860	4.816	−0.357
116	81520	7.002	0.609	0.025	0.136	0.111	1.015	0.113	−0.49	−0.05	5.246	4.557	0.689	4.951	0.295
117	81681	7.160	0.604	0.050	0.130	0.080	1.015	0.081	−0.31	0.07	4.806	4.526	0.280	4.761	0.045
118	83229	6.987	0.568	−0.024	0.091	0.115	1.026	0.118	−0.52	−0.03	4.564	4.298	0.266	4.720	−0.156
119	83489	9.078	0.635	0.088	0.168	0.080	1.022	0.082	−0.32	−0.03	4.718	4.710	0.008	4.948	−0.230
120	84988	6.977	0.593	−0.016	0.118	0.134	1.016	0.136	−0.62	0.08	4.739	4.458	0.281	4.977	−0.238
121	85007	6.851	0.505	−0.068	0.036	0.104	1.083	0.113	−0.48	−0.09	4.516	3.866	0.650	4.260	0.256
122	85042	6.217	0.659	0.220	0.200	−0.020	1.039	−0.021	0.22	0.22	4.764	4.845	−0.081	4.559	0.205
123	86013	8.353	0.558	−0.059	0.081	0.140	1.032	0.144	−0.68	0.13	4.790	4.232	0.558	4.796	−0.006
124	86321	9.724	0.465	−0.117	0.013	0.130	1.131	0.147	−0.69	0.18	4.340	3.577	0.763	4.155	0.185
125	87062	10.266	0.485	−0.209	0.024	0.233	1.107	0.258	−1.67	−0.18	5.175	3.723	1.452	5.047	0.128
126	88945	6.838	0.616	0.087	0.145	0.058	1.016	0.059	−0.20	−0.22	4.864	4.599	0.265	4.724	0.140
127	92270	6.098	0.494	0.015	0.029	0.014	1.096	0.015	0.02	0.07	3.805	3.788	0.017	3.694	0.111
128	92532	7.138	0.536	−0.048	0.061	0.109	1.050	0.114	−0.50	0.06	4.712	4.084	0.628	4.488	0.224
129	92781	9.000	0.561	−0.067	0.084	0.151	1.030	0.156	−0.75	−0.06	4.820	4.252	0.568	4.878	−0.058
130	93185	6.775	0.575	−0.004	0.098	0.102	1.023	0.104	−0.44	−0.15	4.888	4.344	0.544	4.696	0.192
131	94129	8.171	0.617	0.121	0.146	0.025	1.016	0.025	−0.03	0.24	4.399	4.605	−0.206	4.562	−0.163
132	94645	6.232	0.533	0.065	0.058	−0.007	1.053	−0.007	0.15	−0.09	4.032	4.063	−0.031	3.850	0.182
133	96124	7.129	0.664	0.150	0.207	0.057	1.043	0.059	−0.20	0.02	4.954	4.872	0.082	4.999	−0.045
134	96258	5.721	0.464	−0.012	0.013	0.025	1.132	0.028	−0.04	−0.01	3.722	3.570	0.152	3.542	0.180
135	98355	7.445	0.468	−0.092	0.015	0.107	1.127	0.121	−0.53	0.09	3.851	3.599	0.252	4.035	−0.184

Table 2 (*Continued*)

ID	Hip	V_0	$(B-V)_0$	$(U-B)_0$	$(U-B)_{Hya}$	δ	f	$\delta_{0.60}$	[Fe/H]$_{cal}$	[Fe/H]$_{res}$	$(M_V)_{org}$	$(M_V)_{Hya}$	ΔM_V	$(M_V)_{est}$	$(M_V)_{res}$
136	99139	8.809	0.630	0.093	0.162	0.069	1.020	0.070	−0.26	0.11	5.079	4.682	0.397	4.863	0.216
137	99938	8.360	0.566	−0.031	0.089	0.120	1.027	0.123	−0.55	−0.01	4.592	4.285	0.307	4.735	−0.143
138	100017	5.854	0.567	0.045	0.090	0.045	1.027	0.046	−0.14	0.05	4.630	4.292	0.338	4.354	0.276
139	100279	10.039	0.583	−0.070	0.107	0.177	1.019	0.180	−0.93	−0.21	5.137	4.395	0.742	5.168	−0.031
140	100568	8.628	0.541	−0.139	0.065	0.204	1.046	0.213	−1.21	−0.11	5.416	4.118	1.298	5.106	0.310
141	100792	8.310	0.472	−0.182	0.017	0.199	1.122	0.223	−1.30	−0.19	4.462	3.628	0.834	4.686	−0.224
142	102018	7.187	0.594	0.137	0.119	−0.018	1.016	−0.018	0.21	0.08	4.167	4.465	−0.298	4.193	−0.026
143	102046	8.204	0.486	−0.137	0.024	0.161	1.105	0.178	−0.91	0.14	4.245	3.730	0.515	4.488	−0.243
144	102762	8.070	0.575	0.067	0.098	0.031	1.023	0.032	−0.06	−0.02	4.236	4.344	−0.108	4.333	−0.097
145	102805	5.990	0.414	−0.095	0.003	0.098	1.188	0.116	−0.51	−0.19	3.560	3.206	0.354	3.620	−0.060
146	103458	6.507	0.582	−0.045	0.106	0.151	1.020	0.154	−0.74	−0.13	4.781	4.389	0.392	5.007	−0.226
147	103498	8.271	0.514	−0.134	0.043	0.177	1.073	0.190	−1.00	0.11	4.659	3.930	0.729	4.763	−0.104
148	103897	10.083	0.576	0.005	0.099	0.094	1.022	0.096	−0.39	0.28	4.515	4.350	0.165	4.660	−0.145
149	104659	7.343	0.502	−0.164	0.034	0.198	1.086	0.215	−1.22	−0.14	4.662	3.845	0.817	4.844	−0.182
150	107294	9.993	0.462	−0.153	0.012	0.165	1.135	0.187	−0.98	0.16	4.771	3.555	1.216	4.371	0.400
151	107877	6.850	0.477	−0.049	0.019	0.068	1.116	0.076	−0.29	−0.05	3.832	3.664	0.168	3.873	−0.041
152	108468	7.188	0.618	0.110	0.147	0.037	1.016	0.038	−0.09	−0.01	4.569	4.611	−0.042	4.630	−0.061
153	108736	7.088	0.565	0.022	0.088	0.066	1.028	0.068	−0.25	0.04	4.320	4.279	0.041	4.448	−0.128
154	109144	7.216	0.515	0.014	0.044	0.030	1.072	0.032	−0.06	0.02	3.668	3.937	−0.269	3.928	−0.260
155	109381	7.828	0.657	0.208	0.198	−0.010	1.037	−0.010	0.16	0.03	4.686	4.834	−0.148	4.605	0.081
156	109646	7.408	0.510	−0.087	0.040	0.127	1.077	0.137	−0.63	0.01	4.616	3.902	0.714	4.424	0.192
157	110035	7.010	0.590	0.069	0.114	0.045	1.017	0.046	−0.13	0.01	4.551	4.440	0.111	4.499	0.052
158	110341	6.147	0.440	−0.059	0.005	0.064	1.161	0.074	−0.28	−0.19	3.695	3.394	0.301	3.595	0.100
159	110560	10.544	0.540	−0.013	0.064	0.077	1.047	0.081	−0.31	0.22	4.174	4.111	0.063	4.343	−0.169
160	111565	7.571	0.662	0.098	0.204	0.106	1.042	0.110	−0.47	0.01	5.085	4.861	0.224	5.244	−0.159
161	112811	9.283	0.664	0.069	0.207	0.138	1.043	0.144	−0.67	0.03	5.378	4.872	0.506	5.433	−0.055
162	113688	8.596	0.586	0.073	0.110	0.037	1.018	0.038	−0.09	0.05	4.005	4.414	−0.409	4.433	−0.428
163	113896	6.658	0.573	0.047	0.096	0.049	1.024	0.050	−0.16	0.02	4.317	4.331	−0.014	4.412	−0.095
164	114450	8.427	0.552	0.024	0.075	0.051	1.037	0.053	−0.17	−0.12	4.231	4.192	0.039	4.287	−0.056
165	114702	7.529	0.546	−0.043	0.070	0.113	1.042	0.118	−0.51	−0.17	4.570	4.152	0.418	4.573	−0.003
166	114924	5.564	0.519	0.007	0.047	0.040	1.067	0.043	−0.12	−0.12	4.005	3.965	0.040	4.009	−0.004
167	116106	6.480	0.520	−0.031	0.048	0.079	1.066	0.084	−0.33	−0.09	4.395	3.972	0.423	4.222	0.173
168	118115	7.832	0.631	0.139	0.163	0.024	1.020	0.024	−0.02	−0.04	4.426	4.687	−0.261	4.640	−0.214

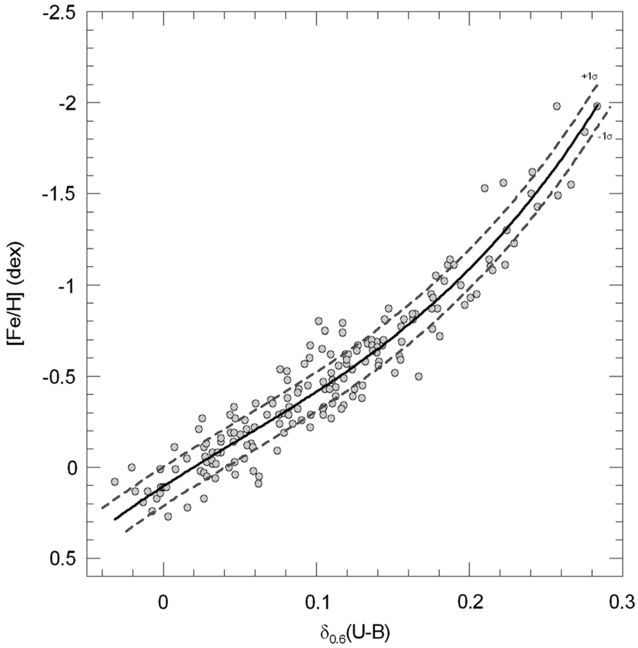

Fig. 4 Metallicity calibration. The *solid line* corresponds to the relation in Eq. (10). The *dashed lines* denote $\pm 1\sigma$ prediction levels

of iron abundances. The mean and the standard deviation of the residuals (Table 2, Fig. 5) are small, $\langle \Delta[\mathrm{Fe/H}] \rangle = 0$ and $\sigma = 0.134$ dex, confirming the accuracy of our procedure.

3.2 Absolute magnitude calibration

We preferred the widely used procedure mentioned in the introduction for the absolute magnitude calibration which is based on the offset from a standard main sequence. The absolute magnitude-colour diagram for the sample stars is given in Fig. 6 confronted to the main sequence of Hyades cluster. The iron abundances of the sample stars are also indicated with different symbols in this diagram, where a trend in the metallicity can be noticed in the direction of the absolute magnitude.

We estimated the differences between the absolute magnitudes of the sample stars and the Hyades' stars of equal $(B-V)_0$ colour, $\Delta M_V = M_V - (M_V)_{Hya}$, and then plotted them against normalized UV excesses, $\delta_{0.6}(U-B)$, (Table 2 and Fig. 7) which yields the following third degree polynomial:

$$\begin{aligned}\Delta M_V = {} & -0.174(0.036) + 5.278(1.141) \times \delta_{0.6} \\ & - 5.292(1.007) \times \delta_{0.6}^2 \\ & + 28.477(5.237) \times \delta_{0.6}^3. \qquad (11)\end{aligned}$$

The correlation coefficient and standard deviation of Eq. (11) are $R^2 = 0.824$ and $\sigma = 0.174$ mag, respectively.

We estimated the absolute magnitudes of the sample stars, $(M_V)_{est}$, by replacing their normalized UV excesses

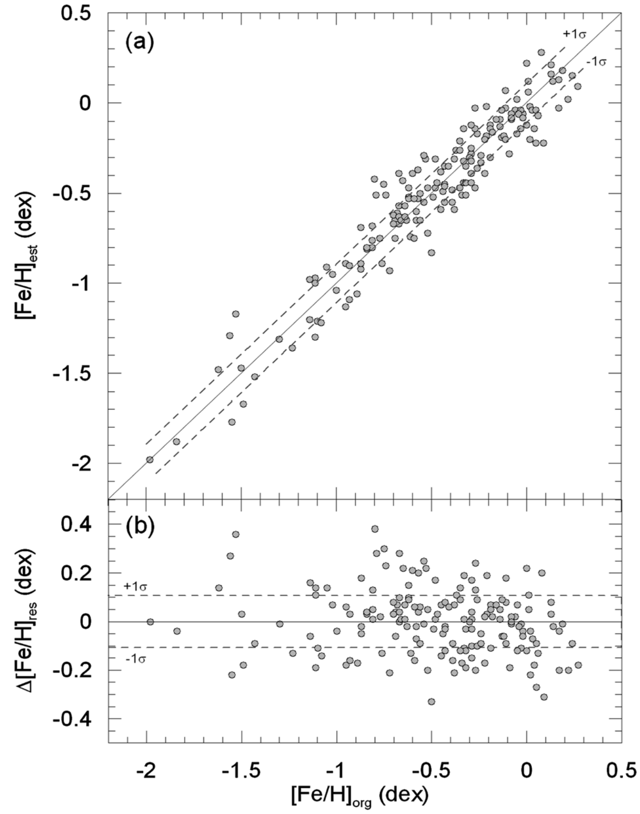

Fig. 5 Comparison of the original ($[\mathrm{Fe/H}]_{org}$) and estimated ($[\mathrm{Fe/H}]_{est}$) metallicities (**a**) and distribution of the metallicity residuals ($\Delta[\mathrm{Fe/H}]_{res}$) respect to the original metallicities (**b**) for the sample stars. The *dashed lines* denote $\pm 1\sigma$ prediction levels

into Eq. (11), and compared them with the original ones, $(M_V)_{org}$, to test the accuracy of the procedure. The comparison is shown in Fig. 8, and the residuals are listed in Table 2. As in the case of iron abundances, there is a linear relation between the two sets of absolute magnitudes, and the mean and the standard deviation of the residuals are small, $\langle \Delta M_V \rangle = 0$ and $\sigma = 0.174$ mag, confirming the accuracy of the procedure used in our study.

3.3 Comparison with other analyses in the literature

The metallicity calibration is carried out with the same procedure descried in Carney (1979), Karaali et al. (2003), Karaali et al. (2011), and Karataş and Schuster (2006). However, there are some differences between these calibrations due to different data.

The metallicity calibrations in the literature and in this study are plotted in Fig. 9 with different symbols, i.e. (+): Carney (1979), (•): Karaali et al. (2003), (□): Karataş and Schuster (2006), (△): Karaali et al. (2011), and (⋆): this study. Our calibration provides richer metallicities, $0.0 < \Delta[\mathrm{Fe/H}] < 0.1$ dex, for the metal-poor stars with $[\mathrm{Fe/H}] < -0.6$ dex respect to the cited calibrations except the ones in

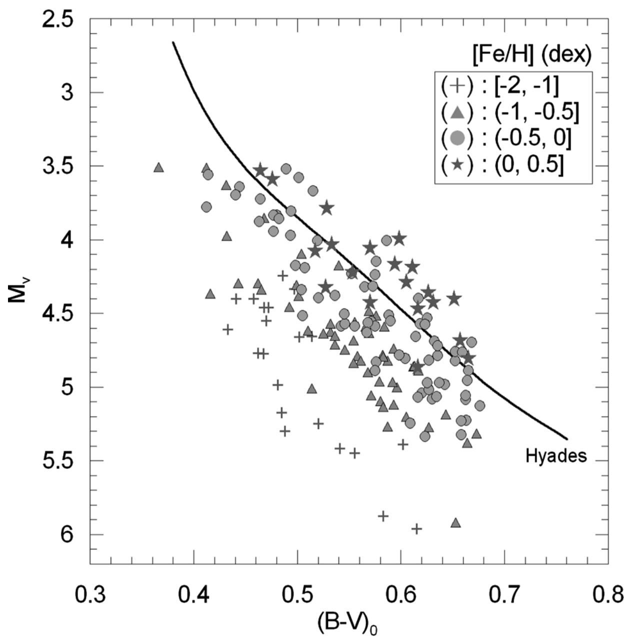

Fig. 6 Colour-absolute magnitude diagram for the sample stars. The *curve* denotes the intrinsic Hyades sequence. *Symbols* correspond to different metallicities as indicated in the panel

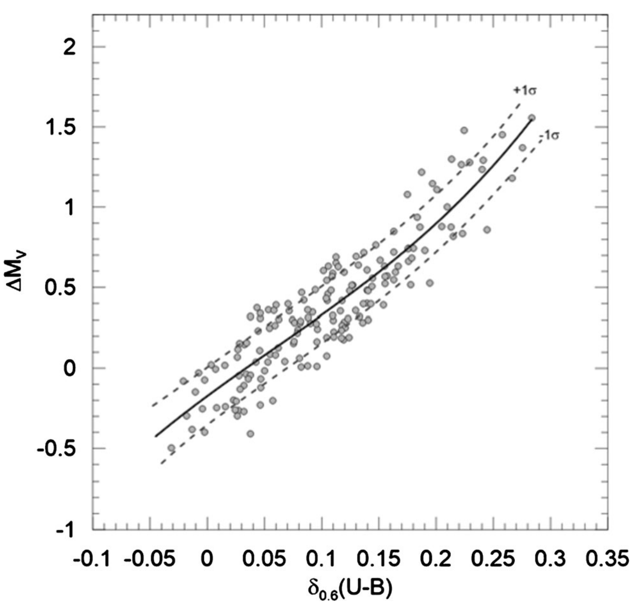

Fig. 7 Absolute magnitude offset versus normalized UV excess for the sample stars. The *solid line* corresponds to the relation in Eq. (11). The *dashed lines* denote $\pm 1\sigma$ prediction levels

Carney (1979) which give poorer metallicities compared to all calibrations mentioned in this study. Metal-rich part of the our calibration is compatible with the one in Karataş and Schuster (2006) in the interval $0.2 < [Fe/H] < 0.4$ dex, and for the intermediate metallicities, $-0.6 < [Fe/H] < 0.2$ dex, our calibration curve occupies a central position with respect to the other ones.

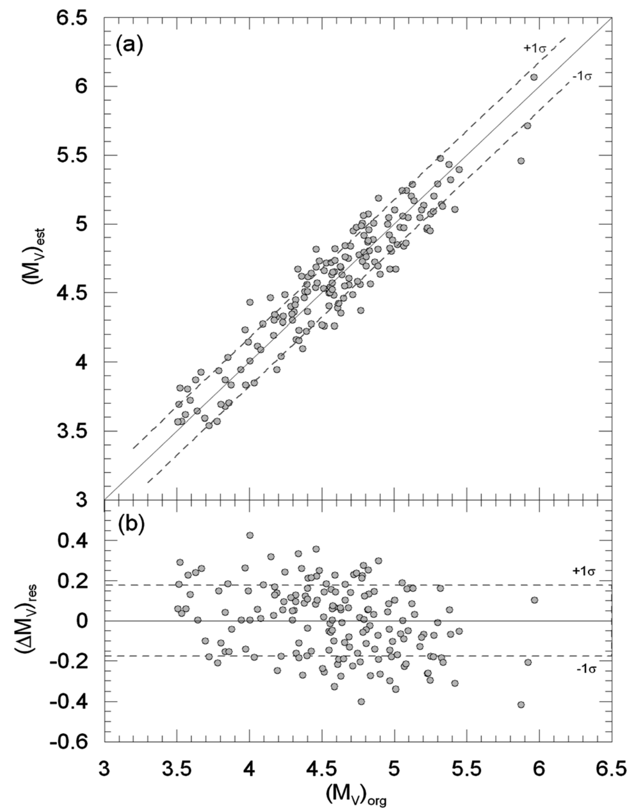

Fig. 8 Comparison of the original $(M_V)_{org}$ and estimated $(M_V)_{est}$ absolute magnitudes (**a**), and distribution of the absolute magnitude residuals $(\Delta M_V)_{res}$ respect to the original absolute magnitudes (**b**), for the sample stars. The *dashed lines* denote $\pm 1\sigma$ prediction levels

We applied the four cited metallicity calibrations to the sample stars used in our study for a further comparison of our results with the ones in cited studies. We replaced their normalized UV excesses, $\delta_{0.6}$, in the corresponding metallicity calibrations in Carney (1979), Karaali et al. (2003, 2011) and Karataş and Schuster (2006), and estimated the iron abundance, $[Fe/H]_{est}$, of each star. Then, we evaluated the residual metallicities, $\Delta[Fe/H]_{res} = [Fe/H]_{org} - [Fe/H]_{est}$, and plotted them in terms of $[Fe/H]_{org}$ in Fig. 10 for each study, where $[Fe/H]_{org}$ denotes the original iron abundances. The means and the corresponding standard deviations of the residuals are $\langle\Delta[Fe/H]\rangle = 0$, -0.03, 0.05, and 0.05 dex; and $\sigma = 0.161$, 0.144, 0.145, and 0.145 dex for the studies in the order given above. The mean of the residuals and their standard deviation, $\langle\Delta[Fe/H]\rangle = 0$ and $\sigma = 0.134$ dex, in our study are equal or smaller than the ones for the cited studies which indicate that the new data used in our study improved the metallicity calibration.

A similar comparison is carried out for the absolute magnitudes. We applied the absolute magnitude calibrations, i.e. ΔM_V offsets versus normalized UV excesses $\delta_{0.6}$, in Laird et al. (1988), Karaali et al. (2003), and Karataş and Schuster (2006) to the sample stars in our study and

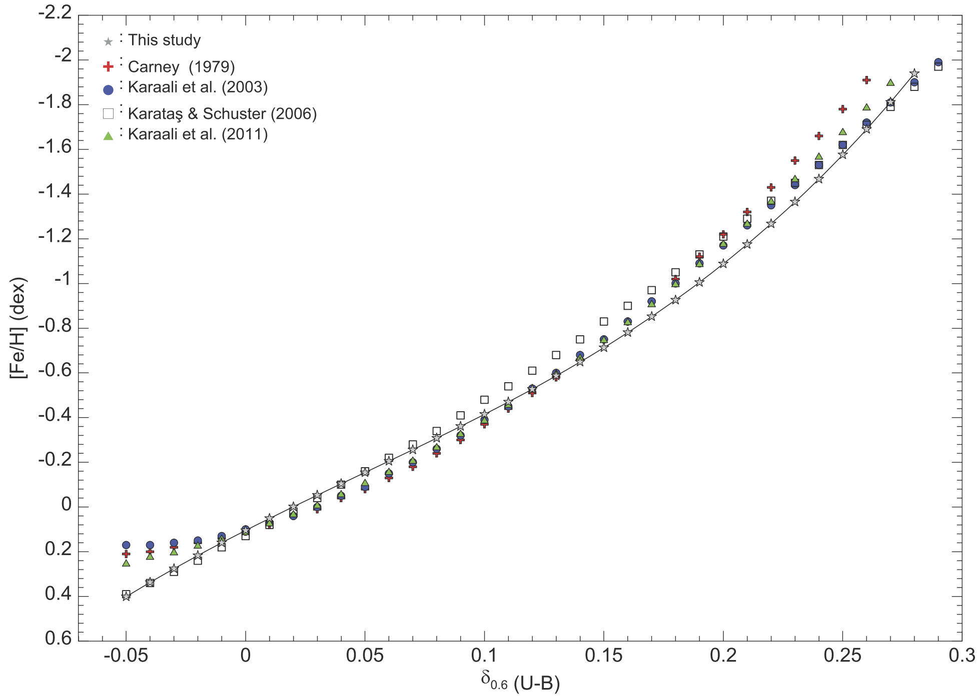

Fig. 9 Comparison of the metallicity calibrations for different studies as indicated in the panel

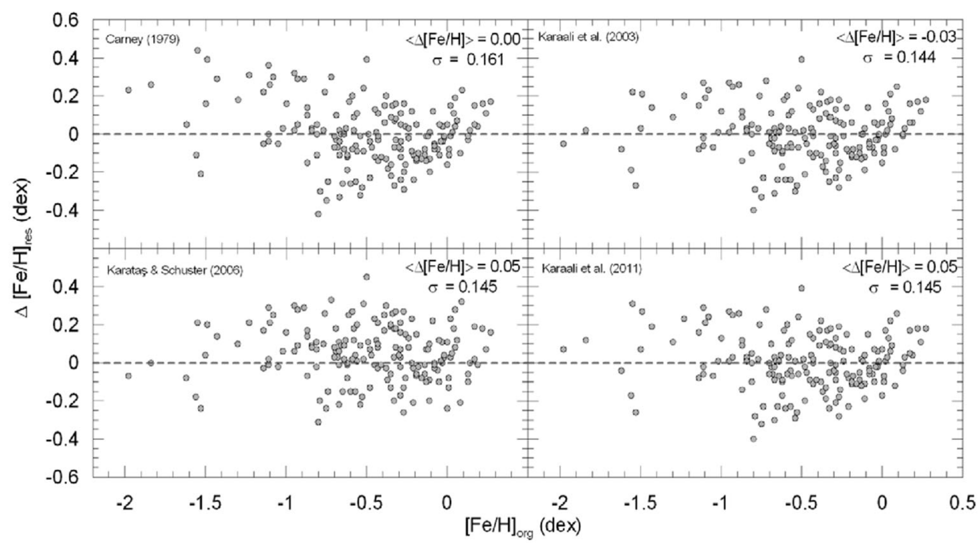

Fig. 10 Distribution of the metallicity residuals $(\Delta[\mathrm{Fe/H}])_{res}$ respect to the original metallicities for four studies as indicated in the panels

estimated their absolute magnitudes $(M_V)_{est}$. Then, we evaluated the residuals $(\Delta M_V)_{res} = (M_V)_{est} - (M_V)_{org}$ and plotted them in terms of $(M_V)_{org}$ in Fig. 11, where $(M_V)_{org}$ denotes the original absolute magnitudes. The mean of the residuals and the corresponding standard deviations are $\Delta(M_V)_{res} = -0.218$, -0.086, and -0.015 mag; and $\sigma = 0.272$, 0.192, and 0.202 mag, for the cited studies in the order given above. The mean of the absolute magnitude residuals (0 mag) and their standard deviation (0.174 mag) in our study are (absolutely) much smaller than the corresponding ones in the cited studies which is a result of the improved data used in our study.

4 Summary

We used a sample of F-G dwarfs taken from different sources and calibrated their iron abundances and absolute magnitudes in terms of UV excesses. We used the re-reduced *Hipparcos* parallaxes (van Leeuwen 2007) for the first time and obtained accurate distances and absolute magnitudes. Our sample consists of 168 dwarf stars covering the colour, iron abundance and absolute magnitude intervals $0.30 < (B-V)_0 < 0.68$ mag, $-2.0 < [\mathrm{Fe/H}] < 0.4$ dex and $3.4 < M_V < 6.0$ mag, respectively. The means and standard deviations of the metallicity and absolute magnitude residuals are small, i.e. $\langle\Delta[\mathrm{Fe/H}]_{res}\rangle = 0$ and $\sigma = 0.134$ dex, and

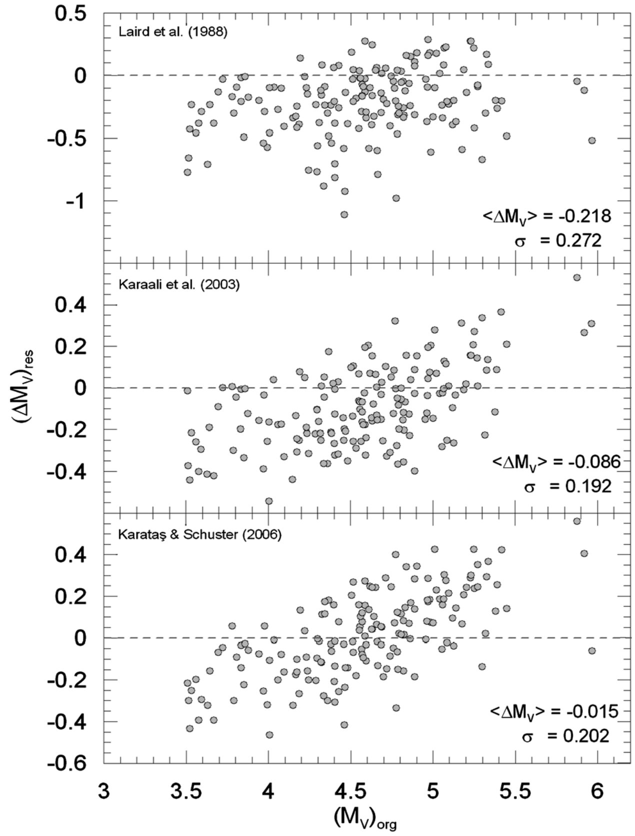

Fig. 11 Distribution of the absolute magnitude residuals $(\Delta M_V)_{res}$ respect to the original absolute magnitudes three studies as indicated in the panels

$\langle \Delta(M_V)_{res} \rangle = 0$ and $\sigma = 0.174$ mag, respectively, which indicate accurate metallicity and photometric parallax estimations.

UBV is the oldest standard photometry in astronomy. Hence, many calibrations are carried out with this system. Although many other photometric systems such as Sloan Digital Sky Survey (SDSS; York et al. 2000), Two Micron All Sky Survey (2MASS; Skrutskie et al. 2006) and Wide field Infrared Survey Explorer (WISE; Wright et al. 2010) are defined on different spectral bands for different purposes, the *UBV* is still widely used due to its advantage, i.e. apparently bright stars for which reliable trigonometric parallaxes and hence distances can be provided in this system. This is the main reason that we preferred the *UBV* photometry in this study. However, we plan to extend this calibrations to other photometric systems which are widely used for other purposes. Our favorite photometric system is the SDSS which provide useful investigations in the Galactic structure. We can use the transformation equations in the literature and transform our calibrations to the SDSS data. Then, we can apply them to a larger sample of stars observed with SDSS photometry. This will be the subject of a second study.

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