

CCD photometric search for peculiar stars in open clusters

VII. Berkeley 11, Berkeley 94, Haffner 15, Lyngå 1, NGC 6031, NGC 6405, NGC 6834 and Ruprecht 130^{*,**}

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ABSTRACT

Aims. The detection of magnetic chemically peculiar (CP2) stars in open clusters of the Milky Way can be used to study the influence of different galactic environments on the (non-)presence of peculiarities, which has to be taken into account in stellar evolution models. Furthermore it is still unknown if the CP2 phenomenon evolves, i.e. does the strength of the peculiarity feature at 5200 Å increase or decrease with age.

Methods. We have observed eight young to intermediate age open clusters in the Δa photometric system. This intermediate band photometric system samples the depth of the 5200 Å flux depression by comparing the flux at the center with the adjacent regions having bandwidths of 110 Å to 230 Å. The Δa photometric system is most suitable to detect CP2 stars with high efficiency, but is also capable of detecting a small percentage of non-magnetic CP objects. Also, the groups of (metal-weak) λ Bootis, as well as classical Be/shell stars, can be successfully investigated. This photometric system allows one to determine the age, reddening and distance modulus by fitting isochrones.

Results. Among the presented sample of eight galactic clusters, we have detected twenty three CP2, eight Be/Ae and eight metal-weak stars. Another six objects show a peculiar behaviour which is most probably due to a non-membership, variability or duplicity. Fitting isochrones to Δa photometry yields estimates of the age, reddening and distance that are in excellent agreement with published values.

Key words. stars: chemically peculiar – stars: early-type – techniques: photometric – Galaxy: open clusters and associations: general

1. Introduction

The continuation of our CCD Δa photometric survey to detect chemically peculiar (CP) stars of the upper main sequence currently comprises the largest sample of open clusters, including young and intermediate age clusters at a variety of galactic longitudes and galactocentric distances.

The Δa photometric system allows one to efficiently detect CP stars and related objects through the flux depression at 5200 Å (Kupka et al. 2004). The efficiency of this system was recently investigated by Paunzen et al. (2005a) surveying a large sample of published field star measurements, resulting in a probability of up to 95% of detecting all relevant magnetic CP stars.

Furthermore the groups of λ Bootis and classical Be/shell systematically show negative Δa values.

Unambiguous detection or non-detection of CP stars in different galactic environments will help to understand their evolution and formation. The aim of this survey is to investigate the occurrence of CP stars in open clusters depending on various parameters like age, metallicity and galactic location. Preliminary results have shown that the percentage of CP2 stars with ages between 30 and 100 Myr have two clear maxima, separated by a deep minimum. Therefore few of open clusters in this paper were selected within that age range to clarify this situation.

Beside the detection of CP stars, we are able to determine cluster parameters like the age, reddening and distance using isochrones for the Δa system (Claret et al. 2003; Claret 2004) which were compared with already published parameters, yielding excellent agreement.

In the presented sample of eight galactic clusters (Berkeley 11, Berkeley 94, Haffner 15, Lyngå 1, NGC 6031, NGC 6405, NGC 6834 and Ruprecht 130) we have detected twenty three CP2, eight Be/Ae, eight metal-weak and six objects showing peculiar behaviour due to doubtful membership, variability or binarity.

* Based on observations at the BNAO Rozhen, CASLEO, CTIO (Proposal 2003A-0057), ESO-La Silla (Proposal 073.C-0144).

** Data are available in electronic form at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via <http://cdsweb.u-strasbg.fr/cgi-bin/qcat?J/A+A/454/171>

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Table 1. Observing log for the programme clusters. All clusters were observed on one night by O. I. Pintado (OIP), M. Netopil (MN), H. M. Maitzen (HMM) and I. Kh. Iliev (IKI).

Cluster	Site	Date	Obs.	# _{g₁}	# _{g₂}	# _y
Be 11	BNAO	02.2005	IKI	10	10	10
Be 94	BNAO	08.2004	IKI	8	8	8
Ha 15	CTIO	04.2003	HMM	11	11	12
Ly 1	ESO	06.2004	MN	10	10	10
N 6031	ESO	06.2004	MN	10	10	10
N 6405	CTIO	04.2003	HMM	8	8	8
N 6834	BNAO	08.2004	IKI	13	14	14
Ru 130	CASLEO	06.2003	OIP	10	10	10

2. Observations, reduction and used methods

Observations of the eight open clusters were performed at four different sites and telescopes:

- 2 m RC telescope (BNAO, Rozhen), direct imaging, SITE SI003AB 1024×1024 pixel CCD and VersArray 1300B camera with EEV chip 1340×1300 pixels, 5′ field-of-view;
- 0.9 m telescope (CTIO), direct imaging, SITE 2084 × 2046 pixel CCD, 13′ field-of-view;
- 3.6 m telescope (ESO-La Silla), EFOSC2, Loral/Lesser 2048×2048 pixel CCD, 5′ field-of-view;
- 2.15 m RC telescope (CASLEO), direct imaging, EEV CCD36-40 1340×1300 pixel CCD, 9′ field-of-view.

The observing log with the number of frames in each filter is listed in Table 1. The observations were performed with two different filter sets, both having the following characteristics: g_1 ($\lambda_c = 5007 \text{ \AA}$, $FWHM = 126 \text{ \AA}$, $T_P = 78\%$), g_2 (5199, 95, 68) and $g_3 = y$ (5466, 108, 70).

The basic CCD reductions and a point-spread-function fitting were carried out within standard IRAF V2.12.2 routines on Personal Computers running under LINUX. The way calculation of the normality line, derivation of the errors as well as the calibration of our $(g_1 - y)$ as well as y measurements is the same as in previous works (see Netopil et al. 2005; and Paunzen et al. 2005b).

The isochrones shown in Figs. 1 to 3 were taken from Claret et al. (2003) and Claret (2004) and are based on the Δa photometric system. The derived ages, reddening and distance moduli together with the errors are listed in Table 2. The fitting procedure takes advantage of the available UBV measurements for all programme clusters which means that the results were compared with those of the color–magnitude–diagrams for the UBV photometric system. However, our determination is based on the Δa measurements alone, which is another important application of this photometric system.

The tables with all data for the individual cluster stars as well as nonmembers are available in electronic form at the CDS, at WEBDA (<http://www.univie.ac.at/webda/>) or upon request from the first author. These tables include the cross identification of objects from the literature, the X and Y coordinates within our frames, the observed $(g_1 - y)$ and a values with their corresponding errors, V magnitudes, the $(B - V)$ colors from the literature, Δa -values derived from the normality lines of $(g_1 - y)$, (disregarding non-members) and the number of observations, respectively.

The diagnostic diagrams for all eight open clusters are shown in Figs. 1 to 3. The normality lines and the confidence intervals corresponding to 99.9% are plotted. The detected

peculiar objects are marked by asterisks. Only members (filled circles) have been used to derive the normality lines. The selection of these objects was done according to their location in the color–magnitude diagrams as well as the distance from the cluster centers and additional information from the literature (proper motions and radial velocities) taken from WEBDA.

3. Results

In the following we will present the results and the comparison with literature values for the individual open clusters. The cluster parameters are given in Table 3. Significant deviating cases are discussed in more detail. The errors of each quantity are given in Tables 2 and 3 and will be not repeated here. For Berkeley 94, NGC 6031 and NGC 6405, estimates of interstellar reddening were published in the Becker RGU and Strömgen $uvby\beta$ system. These values were transformed to $E(B - V)$ according to the following relations: $E(G - R) = 1.39E(B - V)$, Steinlin (1968), and $E(b - y) = 0.74E(B - V)$, Crawford (1978).

The star numbers are from our numbering system based on ascending (X, Y) coordinates on the CCD frames. The Δa indices in units of mmag are always given in parenthesis. Table 3 lists also the star numbers according to WEBDA, if available. Table 4 contains the slopes of the normality lines for the individual open clusters. From the theoretical work of Kupka et al. (2003) this slope (a vs. $(g_1 - y)$) should be ~ 0.20 for the hotter stars. This is only moderately lower than most of our cluster values, with two major exceptions: Berkeley 94 and NGC 6834. Further observations are needed to clarify these substantial deviations.

Berkeley 11: five positive CP detections were obtained. The stars #38 (+45 mmag), 50 (+42) and 64 (+33) are indicated as members in both previous studies of that cluster (Jackson et al. 1980; Yadav & Sagar 2002), although the other two deviating objects #25 (+91) and 54 (+111) are questionable also due to their extremely high Δa indices. Both stars are shifted slightly to the red in the color–magnitude diagram (Fig. 1), but were determined to be non-members by Yadav & Sagar (2002), although #54 is not significant outlying in the $(B - V)$ versus $(U - B)$ diagram. There are several large differences in the available photometry for that cluster. A comparison of the data by Yadav & Sagar (2002) and Jackson et al. (1980), performed by Mermilliod & Paunzen (2003), resulted in differences of $\Delta(B - V) = -0.08$ and $\Delta(U - B) = -0.25$, however the corresponding diagrams of the photometric comparison by Yadav & Sagar (2002) do not show such a behaviour. The interstellar reddening obtained for the cluster, $E(B - V) = 0.95$, is in agreement with all previous studies (Table 3). The determined age of $\log t = 8.0$ is comparable to Yadav & Sagar (2002), whereas Jackson et al. (1980) classified the cluster as much younger. For the distance modulus we derived $m_V - M_V = 15.2$, resulting in a distance of 2.82 kpc which is slightly higher than in the literature (2.2 kpc).

Berkeley 94: the star #67 (+42), determined as a physical cluster member by Yilmaz (1970), and one not previously measured star, #114 (+88), could be identified as classical CP2 stars in the spectral range of about A5. #27 (−54), seems to be a metal-weak star, since it is slightly too cool for a Be/Ae object. However, an estimation of their spectral type on the basis of their calibrated $(B - V)$ colors is difficult due to the small number and range of corresponding measurements in other photometric systems. None of the peculiar objects deviate

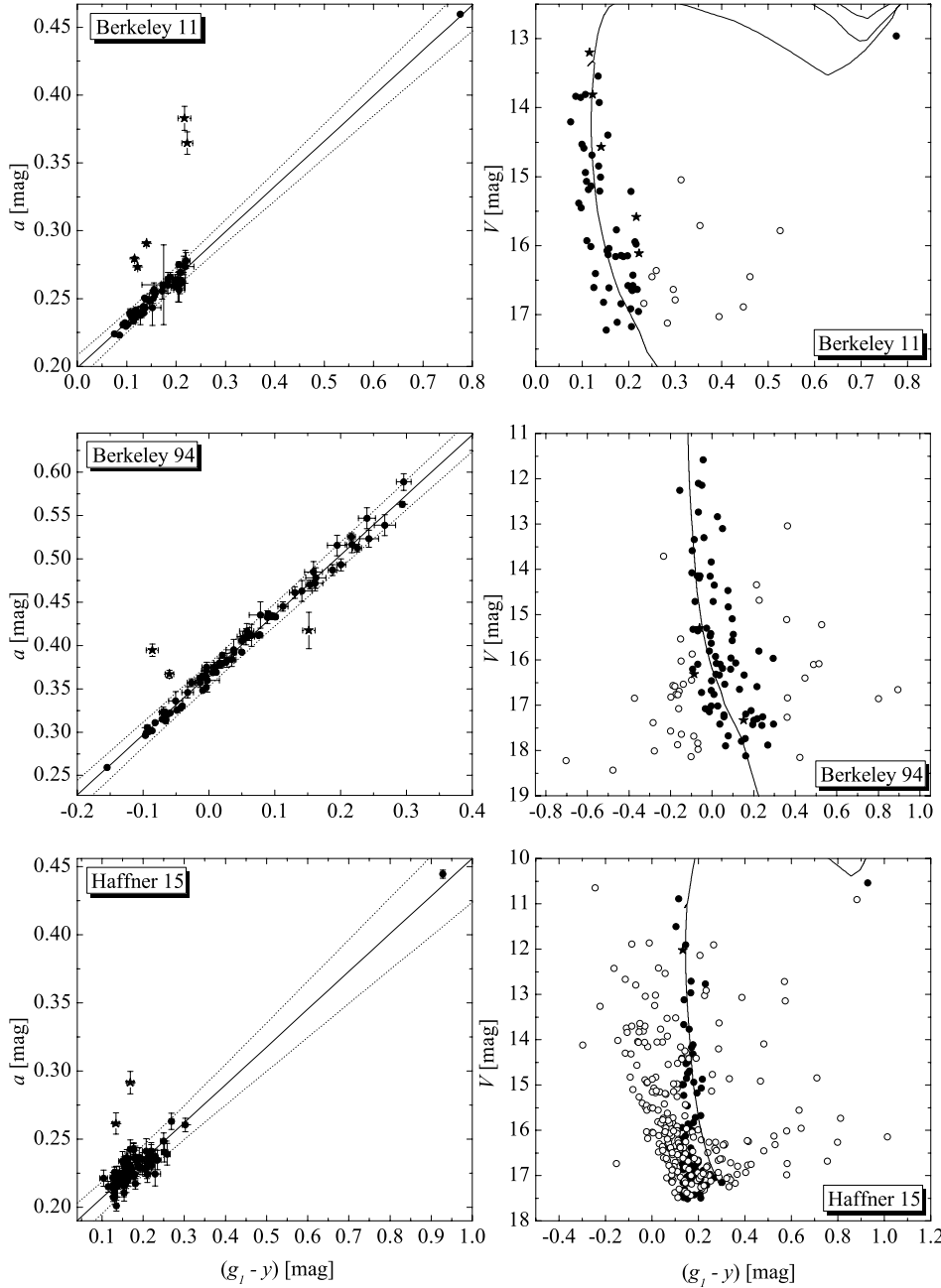


Fig. 1. Observed a versus $(g_1 - y)$ and V versus $(g_1 - y)$ diagrams for our programme clusters. The solid line is the normality line whereas the dotted lines are the confidence intervals corresponding to 99.9% (left panels). The error bars for each individual object are the mean errors. The detected peculiar objects are marked with asterisks. Only members (filled circles) have been used to derive the normality lines. The fitting parameters are listed in Table 4. The isochrones (right panels) were taken from Claret et al. (2003) and Claret (2004) and are based on the Δa photometric system. The derived ages, reddening and distance moduli are given in Table 2.

from the cluster main sequence (Fig. 1), which supports their membership status, but additional investigations are necessary. The determined age, $\log t = 7.0$, and interstellar reddening, $E(B - V) = 0.65$, for Berkeley 94 are in agreement with the results from the literature. A comparison of the distances is more difficult. The distance of 3.3 kpc ($m_V - M_V = 14.6$) is only comparable to the value derived by Fitzsimmons (1993, 3.5 kpc). The other two works (Yilmaz 1970; Wrandemark 1978) list 1.61 and 5 kpc, respectively. These discrepancies deserve further attention. Yilmaz (1970) stated that his published photometric measurements are rather uncertain due to technical problems. Wrandemark (1978), on the other hand, analysed only 13 stars resulting in a poor representation of the

main sequence. This might cause the widely different distance estimations.

Haffner 15: two deviating stars were found within the poorly populated and investigated cluster Haffner 15. The objects #109 (+45), a member according to Vogt & Moffat (1972), and #190 (+66) are candidates for classical CP2, mid B-type stars. Our obtained values for interstellar reddening, $E(B - V) = 1.10$, and distance, 2.2 kpc ($m_V - M_V = 15.13$), are in agreement with the result Vogt & Moffat (1972). The age was determined for the first time to our knowledge as $\log t = 7.2$, however the catalogue by Dias et al. (2002) lists an almost identical age of $\log t = 7.17$ for that cluster.

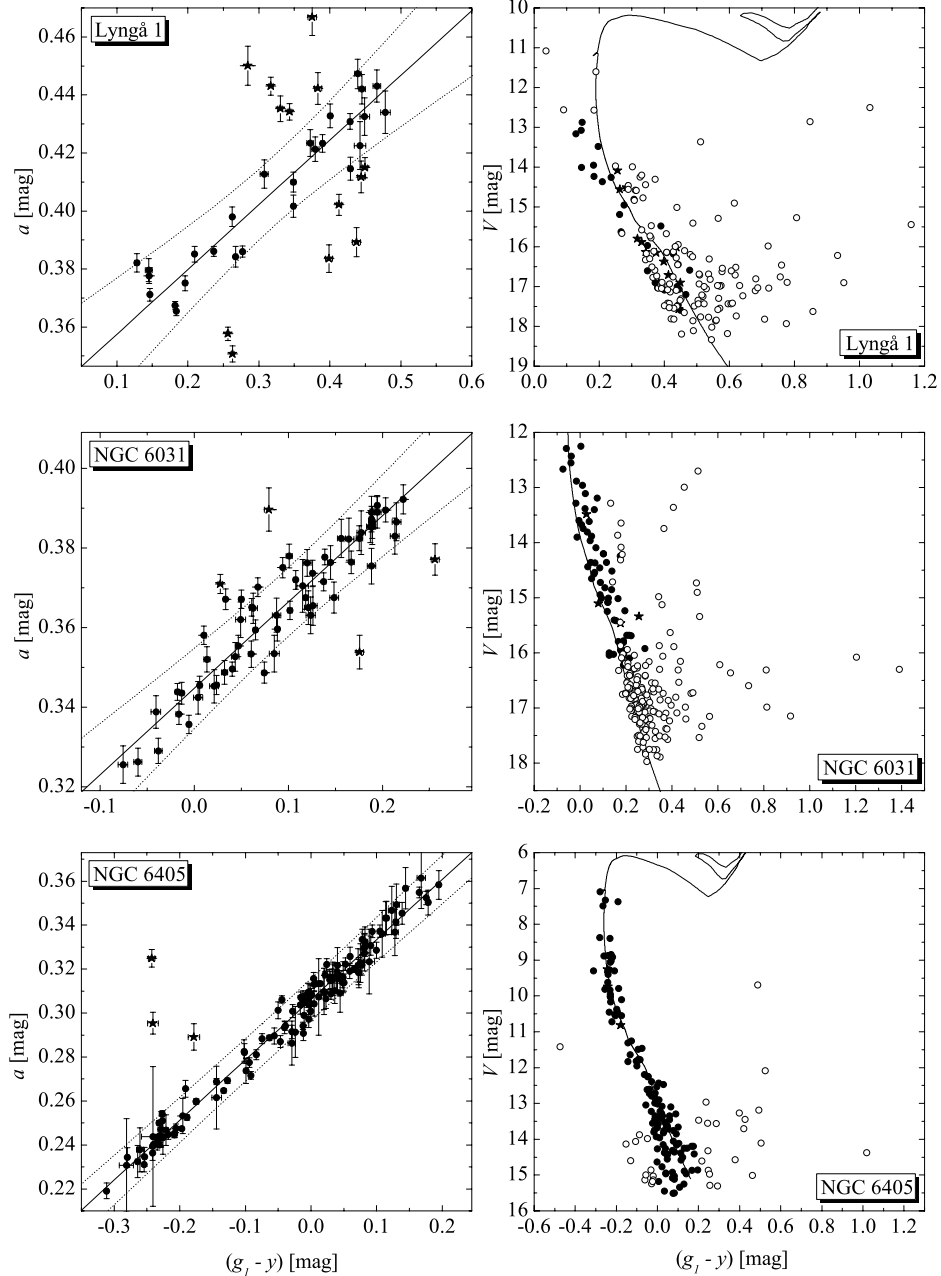


Fig. 2. Observed a versus $(g_1 - y)$ and V versus $(g_1 - y)$ diagrams for our programme clusters. The symbols are the same as in Fig. 1.

The obtained CCD-photometry displayed in Fig. 1 shows stars in the cluster area within a diameter of $3'$ by filled circles. Open circles denote objects which by their position in the HR-diagram should be considered as non-members of Haffner 15. Since we notice a blue branch among them, suggesting the presence of an even younger stellar aggregate in the vicinity of Haffner 15, we investigate this possibility by exploring its local relationship to the cluster. We found that these “young” stars are, indeed, not distributed equally over the image area, but are concentrated in the southwest of the cluster. On the other hand, a stellar group significantly younger than Haffner 15 would imply star formation, hence interstellar material with an $H\alpha$ signature. Inspection of the POSS data excluded this possibility. From the distribution of interstellar extinction (Neckel & Klare 1980) we deduce from Field 94 (centered on $l = 247^\circ$ and $b = -5^\circ$) that beyond the distance of 1000 pc the field exhibits extreme diversity: the values cover the interval from less than 1 to nearly 4 mag of

visual absorption. We conclude that the allegedly young stars, despite of their angular coherence, are not an expanding (young) association, but are located along the reddening vector direction in Fig. 1 with lower interstellar extinction than the cluster, thus mimicking a stellar aggregate younger than Haffner 15.

Lyngå 1: was recently investigated by Vázquez et al. (2003) who reported the finding of a red supergiant member, but unfortunately we are not able to measure that star due to saturation. Since it is difficult to fit an appropriate isochrone without it, we have used $\log t = 8.0$, roughly the average of previous studies, to fit the remaining parameters and determined them as $E(B - V) = 0.50$ and $m_V - M_V = 13.0$ which is consistent with the literature values. Since about two thirds of the probable members according to Vázquez et al. (2003) exhibit peculiar behaviour, we set a cut off at late F-type based on calibrated $(B - V)$ color indices and the obtained reddening

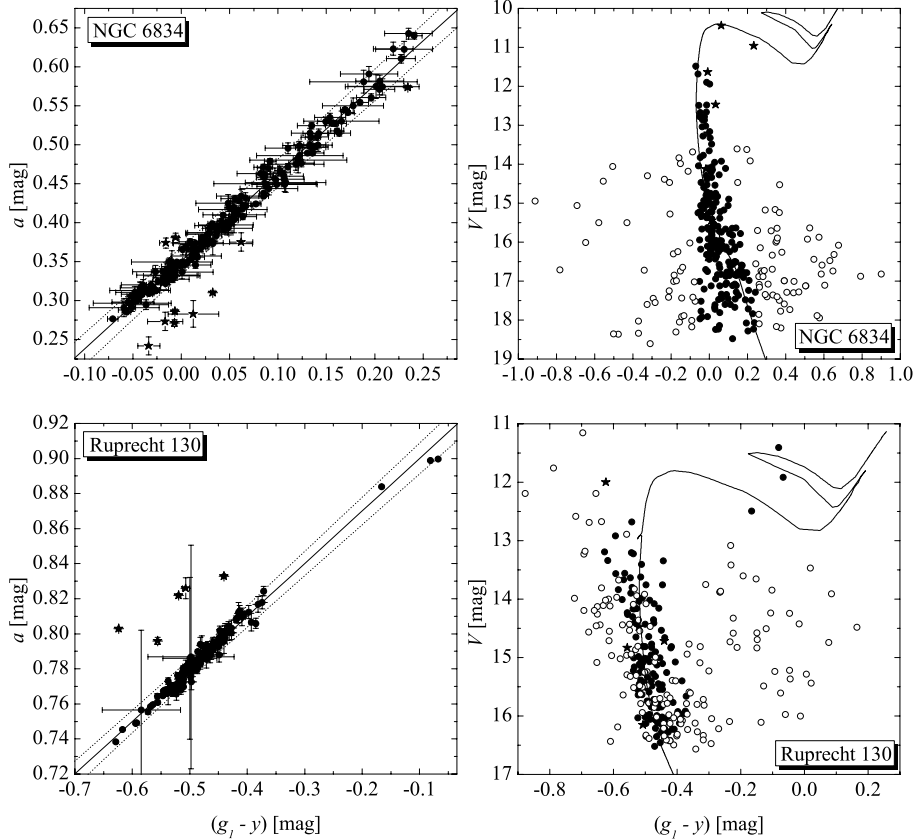


Fig. 3. Observed a versus $(g_1 - y)$ and V versus $(g_1 - y)$ diagrams for our programme clusters. The symbols are the same as in Fig. 1.

value. This is justifiable because CP stars are only expected up to a spectral type of F5. Using this restriction, thirteen stars (see Table 2 for the complete listing) out of forty probable members deviate from the normality line, still an extremely high number. The objects #105 (-35) and 127 (-43) are candidates on the border to be Ae stars, whereas the other five objects showing a negative Δa index are possible metal-weak stars. The six detected CP2 stars are in the spectral range of about A6 to F4 with Δa indices between $+22$ and $+51$ mmag. One suspected variable star, #82 ($+51$), was found within that group of peculiar objects. Our calibrated V magnitude deviates compared to all available measurements: $+0^m.36$ (Peterson & Fitzgerald 1988) and $-0^m.53$ (Vázquez et al. 2003). This object is therefore marked as questionable in Table 2. Further membership and spectroscopic investigations for this cluster are planned in the near future.

NGC 6031: since a few stars lie outside the confidence interval, an Δa index of 20 mmag was set as the threshold for peculiarity. On the basis of that limit, four objects show a peculiar behaviour. The stars #29 ($+28$) and 35 ($+20$) are candidates for classical CP2 stars, whereas the stars #69 (-29) and 199 (-23) are metal-weak objects, since they are too cool to be Be/Ae objects. All deviating stars are members according to Topatkas (1981) and/or Lindoff (1967). The objects fainter than about $16^m.2$ seem to be field stars because they deviate extremely from the normality line. Such a field population exhibits a main sequence in the color–magnitude diagram (Piatti et al. 1999). Our determined reddening of $E(B - V) = 0.50$ is in agreement with previous results, whereas the other cluster parameters deviate between the different investigations. The age was formerly defined as $\log t = 7.5$ by Lindoff (1967) and 8.3

(Piatti et al. 1999) which correspond to our result of $\log t = 8.2$. For the cluster distance the result of 1.5 kpc ($m_V - M_V = 12.45$) is an average of the former studies, excluding Lindoff (1967) and Piatti et al. (1999) who obtained the larger distances of 3.2 and 2.1(7) kpc, respectively.

NGC 6405: the open cluster NGC 6405 was investigated by Maitzen & Schneider (1984) who obtained photoelectric Δa measurements. It was included in our CCD-survey in order to compare the detection performance of both techniques employed, yielding excellent agreement of the three stars #33 ($+32/+33$), 65 ($+55/+67$) and 135 ($+85/+94$) detected in both investigations. The Δa indices in mmag of the present and previous study are given within brackets. A very good agreement is seen although there is a decrease of the Δa -effect by about 10% for at least two objects. This might be explained by the intrinsic variability of these objects.

A more reasonable argument is the difference in the filter set used by Maitzen & Schneider (1984), who had their longest wavelength filter displaced by about 30 \AA to the red, therefore better representing the continuum level. Two stars (#65 & 135) were also recognized as CP2 stars within the Geneva photometric system (North & Cramer 1981). The remaining star #33 seems to be a nonmember since it is an outlier in the two color ($B - V$) versus ($U - B$) diagram, but this object will be investigated spectroscopically in the near future to clarify its status. The cluster parameters determined via Δa isochrone fitting, $\log t = 8.0$, $E(B - V) = 0.2$ and $m_V - M_V = 8.9$ are in concordance with all previous studies (see Table 3).

NGC 6834: our determined parameters, $\log t = 7.9$, $E(B - V) = 0.70$ and $m_V - M_V = 13.6$ are in good agreement

Table 2. Summary of results; the age, distance modulus, reddening and thus the distance from the Sun was derived by fitting isochrones to the Δa photometry. R_V was set to 3.1. For the distance of the Sun from the galactic center, a value of 8.5 kpc was used, the Trumpler classification was taken from Lyngå (1987) and the errors in the final digits of the corresponding quantity are given in parenthesis. Questionable peculiar stars are marked by asterisks (see the corresponding cluster result section for details). All photometric values are in units of mmags.

Name	Berkeley 11 C0417+448	Berkeley 94 C2220+556	Haffner 15 C0743-326	Lyngå 1 C1356-619
l/b	157.08/-3.64	103.13/-1.18	247.94/-4.16	310.86/-0.35
$E(B - V)$ (± 0.05)	0.95	0.65	1.10	0.50
$m_V - M_V$ (± 0.2)	15.2	14.6	15.1	13.0
d [kpc]	2.82(46)	3.29(54)	2.21(36)	1.95(32)
R_{GC} [kpc]	11.15(44)	9.79(30)	9.55(21)	7.37(15)
$ z $ [pc]	179(29)	68(11)	160(26)	12(2)
$\log t$ (± 0.1)	8.0	7.0	7.2	8.0
Tr-type	II 2 m	II 3 p	II 2 m	II 2 p
n (member)	54	77	83	40
n (none)	12	38	246	126
CP No. (Webda):	*25(322): +91/+123/+911	27(-): -54/-/+2737	109(3): +45/-214/-3078	8(58): +48/+371/+3153
$\Delta a/(B - V)_0/M_V$	38(188): +45/-84/-631	67(4): +42/-/+696	190(-): +65/-129/1867	15(53): +26/+280/+2880
[mmag]	50(128): +42/-146/-2000 *54(255): +111/+109/+384 64(313): +33/-130/-1390	114(-): +88/-/+1719		22(56): -44/+498/+3016 81(80): -25/+448/+3710 *82(40): +51/+187/+1510 93(57): +22/+307/+3132 103(52): +37/+253/+2801 105(24): -35/+130/+1089 109(125): -23/+512/+4570 111(87): -21/+523/+3909 112(85): +22/+388/+3912 127(31): -43/+143/+1556 134(67): -41/+420/+3378
n (frames)	30	24	34	30
Name	NGC 6031 C1603-539	NGC 6405 C1736-321	NGC 6834 C1950+292	Ruprecht 130 C1744-301
l/b	329.29/-1.55	356.62/-0.74	65.71/+1.19	359.21/-0.98
$E(B - V)$ (± 0.05)	0.50	0.20	0.70	1.20
$m_V - M_V$ (± 0.2)	12.45	8.9	13.6	15.0
d [kpc]	1.51(25)	0.45(7)	1.93(32)	1.80(30)
R_{GC} [kpc]	7.24(20)	8.05(7)	7.90(6)	6.70(30)
$ z $ [pc]	41(7)	6(1)	40(7)	31(5)
$\log t$ (± 0.1)	8.2	8.0	7.9	7.9
Tr-type	I 3 p	II 3 r	II 2 m	II 1 p
n (member)	67	134	201	140
n (none)	176	33	107	155
CP No. (Webda):	29(85): +28/+151/+2651	*33(7): +32/+57/+1915	8(128): -82/+30/+1854	71(-): +35/+83/-285
$\Delta a/(B - V)_0/M_V$	35(73): +20/+24/+1034	65(19): +55/-90/+839	*32(125): -42/+771/-2637	79(1): +33/-187/-169
[mmag]	69(70): -29/+387/+3017 199(54): -23/+583/+2893	135(77): +85/-94/+357	*129(1): -46/+196/-3158 137(-): +41/-64/+1706 139(412): +36/-31/+2797 198(67): -78/+97/-1128 202(42): -59/-68/+526 234(55): -57/-34/-385 294(155): -71/-124/+1739 297(73): -72/-35/-1963	227(-): +48/-72/+1157 250(108): +60/-345/-2997
n (frames)	30	24	41	30

with the results found in the literature, except Johnson (1961) who obtained a much larger distance. The age is identical to the one listed by Moffat (1972), the only available work that has investigated the cluster age. In total ten peculiar objects were found (see Table 2) among possible members according to their location within the color-magnitude diagram or the investigation by Fünfschilling (1967). The evolved stars #32 (-42) and 129 (-46), showing a possible emission, were investigated spectroscopically by Sowell (1987), classified as G0/5 III/V and F2 Ib, respectively. The object #32 was determined as a possible foreground star and #129 showed an increase in brightness in the B and V passbands of 0.2 to 0.3 mag during a

period of ninety days, however #129 is a double star according to Mason et al. (2002). Both objects are therefore questionable and are marked in Table 2 by asterisks. All other “negative” stars are candidates for Be/Ae objects, whereas #198 (-78), 234 (-57) and 297 (-72) can be also found in the catalogue of $H\alpha$ emission stars by Kohoutek & Wehmeyer (1999). In addition, two positive CP2 detections for the objects #137 (+41) & 139 (+36) were observed.

Ruprecht 130: five possible CP2 stars were detected in the cluster Ruprecht 130, #71 (+35), 79 (+33), 92 (+48), 227 (+48) and 250 (+60). Unfortunately no membership analysis is

Table 3. Comparison of our results (bold face) with already published cluster parameters. The errors of the last digit are given in parentheses if available. If interstellar extinction was given in other photometric systems (* *RGU*, ** *uuby*) they were transformed to $E(B - V)$ as described in Sect. 3. The following references, sorted by cluster and year, are given in the last column: (1) Jackson, Fitzgerald & Moffat (1980); (2) Yadav & Sagar (2002); (3) Yilmaz (1970); (4) Wramdemark (1978); (5) Fitzsimmons (1993); (6) Vogt & Moffat (1972); (7) Peterson & Fitzgerald (1988); (8) Vázquez et al. (2003); (9) Kharchenko et al. (2005); (10) Lindoff (1967); (11) Moffat & Vogt (1975); (12) Fenkart & Binggeli (1979); (13) Topatkas (1981); (14) Piatti et al. (1999); (15) Rohlfs et al. (1959); (16) Eggen (1961); (17) Talbert (1965); (18) Vleeming (1974); (19) Schneider (1985); (20) Johnson (1961); (21) Fünfschilling (1967); (22) Moffat (1972); (23) Piatti et al. (2000).

Cluster	$\log t$	$E(B - V)$	d [kpc]	Ref
Be 11	8.0(1)	0.95(5)	2.82(46)	
	7.5	0.96(6)	2.2(2)	1
	8.05(5)	0.95(5)	2.2(1)	2
Be 94	7.0(1)	0.65(5)	3.29(54)	
		0.48*	1.61	3
	7.0	0.65	5	4
	6.8	0.65**	3.5	5
Ha 15	7.2(1)	1.10(5)	2.21(36)	
		1.16(8)	2.49	6
Ly 1	8.0(1)	0.50(5)	1.95(32)	
	7.9	0.45(2)	1.98	7
	8.05	0.45(3)	1.9(1)	8
	8.15	0.46	2.28	9
N 6031	8.2(1)	0.50(5)	1.51(25)	
	7.5	0.43(3)	3.2	10
		0.47(5)	1.09	11
		0.45	1.78	12
		0.33*	1.59	13
	8.3(3)	0.40(15)	2.1(7)	14
N 6405	8.0(1)	0.20(5)	0.45(7)	
	8.0	0.16	0.63(5)	15
		0.13	0.50	16
		0.16	0.48(5)	17
	8.0	0.15	0.45(5)	18
		0.15**		19
	7.91	0.14	0.49	9
N 6834	7.9(1)	0.70(5)	1.93(32)	
		0.72	3.03	20
		0.61	2.1	21
	7.9	0.72	2.14	22
Ru 130	7.9	1.20(5)	1.8(30)	
	7.7(1)	1.20(5)	2.1(4)	23

available in the literature. However, the detected CP2 stars are not outstanding within the color magnitude diagram (Fig. 3), except star #250 which appears much bluer. This can be interpreted by the “blueing” effect, typical for some magnetic CP objects due to stronger UV absorption than in normal stars (Adelman 1980). For the determined cluster parameters, $\log t = 7.9$, $E(B - V) = 1.20$, $m_V - M_V = 15.0$, only marginal discrepancies from the study by Piatti et al. (2000) can be found. The isochrone fitting is difficult without knowledge of the membership status for the three evolved stars. However, their location close to the normality line supports membership.

4. Conclusions

Within the presented sample of eight galactic open clusters, 1689 objects on 243 frames using four different sites were investigated, resulting in the detection of twenty three CP2, eight Be/Ae (three previously identified) and eight metal-weak objects.

Table 4. The regression coefficients for the transformations and normality lines. The absolute values and errors vary due to the inhomogeneous “standard” observations (photographic, photoelectric and CCD) found in the literature as well as the dependence on the magnitude range in common, i.e. a broader range guarantees a small error. The offsets are due to the four different telescopes and thus instruments as well as CCD used (Table 1), the deviating results for the slopes are discussed in the beginning of Sect. 3. The errors in the final digits of the corresponding quantity are given in parentheses.

Cluster	$V = a + b \cdot (y), N$	$a_0 = a + b \cdot (g_1 - y), N$
Be 11	-3.54(13)/1.01(1)/66	0.199(1)/0.334(6)/49
Be 94	-2.70(36)/0.93(2)/14	0.366(1)/0.692(7)/74
Ha 15	-5.46(37)/1.01(2)/13	0.179(2)/0.277(9)/79
Ly 1	-0.26(4)/1.01(1)/127	0.335(5)/0.223(14)/25
N 6031	-0.12(4)/1.01(1)/151	0.345(1)/0.217(9)/63
N 6405	-5.88(11)/1.03(1)/107	0.306(1)/0.274(3)/131
N 6834	-2.70(33)/0.95(2)/120	0.351(1)/1.129(9)/192
Ru 130	-5.32(6)/1.00(1)/111	0.930(2)/0.299(4)/136

A further six deviating stars are designated as questionable either due to their membership status or because they have been identified as variable or double stars.

As an important application of the Δa photometric system, isochrones were fitted to the color–magnitude-diagrams (V versus $(g_1 - y)$) of the programme clusters. For this purpose, our measured y magnitudes were directly converted into standard V magnitudes on the basis of already published values. A comparison of our results yields an excellent agreement with the corresponding parameters from the literature.

The programme clusters yield a wide spread of different galactic environments (galactic longitude, galactocentric distances) and ages (10 to 160 Myr), useful for the ongoing investigation on the incidence of peculiar stars. There is special interest in the cluster Lyngå 1, which has an extremely large number of peculiar stars with respect to the quantity of probable members ($\sim 30\%$), but further spectroscopic and membership investigations are required to support this finding.

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