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Membership of 23 stars towards the bulge globular clusters NGC 6528 and NGC 6553*

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Abstract. Low resolution spectra of 23 stars towards the bulge globular clusters NGC 6528 and NGC 6553 are analysed. Radial velocities and atmospheric parameters are derived in order to check their membership in the clusters. Effective temperatures were obtained from photometric data for stars with $T_{\rm eff} > 3800$ K, whereas for cooler stars, they were derived from equivalent widths of TiO bands. Calibrations of W(TiO) as a function of stellar parameters based on a grid of synthetic spectra are presented. Metallicities were derived from a comparison of the observed spectra to a grid of synthetic spectra. The sample comprises evolutionary stages from the Red Giant Branch to the Horizontal Branch, with parameters in the range $3200 \leq T_{\rm eff} \leq 5000$ K and $-0.5 \leq \log g \leq 2.4$. The mean metallicities obtained for NGC 6528 and NGC 6553 are [Fe/H] ≈ -0.5 and -0.7, in both cases with [Mg/Fe] $= +0.3$; assuming the same overabundance for the α elements O, Mg, Si, S, Ca and Ti, this gives $[Z/Z_\odot] = -0.25$ and -0.45. Membership verification by means of low resolution spectra is a crucial step in preparing targets for high resolution spectroscopy with 8 m class telescopes.

Key words. clusters: globular: NGC 6528, NGC 6553 – stars: abundances

1. Introduction

The study of the stellar populations in the Galactic bulge is very important to constrain possible models of galaxy formation. In particular, the determination of the metallicities and abundance ratios of bulge stars, either from the field or in clusters, provides key information to help decide among the possible scenarios for the history of chemical enrichment of the Galaxy.

There are few previous studies of radial velocities and metallicity estimations of bulge stars from low resolution spectra. In the analysis of 400 field bulge stars by Sadler et al. (1996), metallicities and [Mg/Fe] values were estimated. Minniti (1995a,b) studied the membership of stars towards 7 bulge globular clusters.

The best studied among the bulge globular clusters are NGC 6528 ($\alpha_{2000} = 18^{\rm h}04^{\rm m}49.6^{\rm s}$, $\delta_{2000} = -30^{\rm o}03'20.8''$) and NGC 6553 ($\alpha_{2000} = 18^{\rm h}09^{\rm m}15.7^{\rm s}$, $\delta_{2000} = -25^{\rm o}54'27.9''$). Ortolani et al. (1995) have shown that, besides being old, these clusters have luminosity functions which are very similar to that of Baade's Window, which indicates that they belong to the same stellar population.

NGC 6528 is located in the Baade Window, at a distance $d_\odot = 7.83$ kpc from the Sun, and NGC 6553 is relatively close to the Sun, at a distance $d_\odot = 5.1$ kpc (Barbuy et al. 1998). As they are both located in crowded fields, the measurement of radial velocities of individual stars is of crucial importance for the determination of their membership in the clusters.

Both clusters are known to be metal-rich. However, there is no consensus in the literature regarding their detailed metal abundances. Recently, Barbuy et al. (1999) analysed high resolution spectra of two giant stars of

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NGC 6553. An Iron abundance of [Fe/H] = -0.55 ± 0.2 and abundance ratios [Na/Fe] $\approx$ [Al/Fe] $\approx$ [Ti/Fe] $\approx$ +0.5, [Mg/Fe] $\approx$ [Si/Fe] $\approx$ [Ca/Fe] $\approx$ +0.3 were derived. These ratios imply an overall metallicity $[Z/Z_{\odot}] \approx -0.1$. Cohen et al. (1999), analysing high resolution spectra of five red horizontal branch stars, obtained a mean metallicity [Fe/H] = -0.16 and an excess of the α-element calcium to iron of about 0.3 dex, which imply an overall metallicity $[Z/Z_{\odot}] \approx +0.1$. Metal abundances of these clusters are also discussed in Barbuy et al. (1999) and Barbuy (2000).

In view of the disagreement between previous determinations of [Fe/H], it is important that abundance estimations be extended to a larger number of stars of both clusters. In this paper, we determine radial velocities, effective temperatures, gravities and estimations of metallicities [Fe/H] based on low resolution spectra for 23 stars towards NGC 6553 and NGC 6528, and verify their membership in these clusters.

In Sect. 2 the observations are described. The radial velocities derived are presented in Sect. 3. In Sect. 4 the stellar parameters are derived, and synthetic spectra are compared to observations to estimate metallicities. Concluding remarks are given in Sect. 5.

2. Observations

Low resolution spectra of individual stars of NGC 6528 and NGC 6553 were obtained in 1992 August and 1994 June, at the 1.5 m ESO telescope at ESO (La Silla). The Boller & Chivens spectrograph was employed. In 1992 August the Thompson CCD # 18 with 1024×1024 pixels, with a pixel size of 19 μm was used. A resolution of $\Delta\lambda \sim 8$ Å and a spectral coverage of $\lambda\lambda$ 4800–8800 Å were achieved. In 1994 June, the Ford Aerospace FA 2048 L, frontside illuminated, uncoated CCD detector (ESO # 24) with 2048×2048 pixels and pixel size 15×15 μm was used. The grating # 27 resulted in a spectral resolution $\Delta\lambda \sim$ 4 Å and a spectral coverage in the range $\lambda\lambda$ 4800–7550 Å.

The log of observations is provided in Table 1. The stars are identified according to the charts by Hartwick (1975) for NGC 6553 and van den Bergh & Younger (1979) for NGC 6528. Spectra of a given star were co-added by weighting their S/N ratios; the final S/N are indicated in Table 1.

In Figs. 1 and 2 are shown the V vs. $V-I$ Colour-Magnitude Diagrams of NGC 6528 and NGC 6553 using data obtained with the Hubble Space Telescope (Ortolani et al. 1995) where the sample stars are identified.

Table 1. Log of observations.

Star	V	$V-I$	Exp. (s)	Date	S/N
NGC 6528					
I 1	16.10	1.93	5400	06.08.92	190
I 2	15.73	2.59	1800	16.06.94	25
			5400	06.08.92	75
I 5	15.37	2.22	2700	17.06.94	20
I 6	15.89	3.54	2700	17.06.94	40
II 8	15.71	2.19	2100	17.06.94	20
II 14	15.76	3.47	2700	17.06.94	10
I 23	17.19	1.70	1800	16.06.94	10
I 24	16.89	1.66	4500	17.06.94	20
I 25	16.11	2.09	4500	16,17.06.94	40
I 27	15.90	3.08	1800	16.06.94	20
			5400	06.08.92	100
I 36	16.41	1.98	2100	17.06.94	20
II 39	15.88	2.30	2100	17.06.94	30
I 40	15.93	2.08	2100	17.06.94	20
I 42	16.42	2.15	2100	17.06.94	30
II 70	15.85	2.36	1800	16.06.94	20
NGC 6553					
III 2	16.89	1.95	1800	16.06.94	20
III 3	15.82	2.41	3600	14,16.06.94	25
			5400	07.08.92	100
III 17	15.36	3.01	1800	14.06.94	30
II 51	15.48	2.54	1800	17.06.94	10
			5400	07.08.92	80
II 52	16.84	1.93	1800	17.06.94	40
			5400	07.08.92	230
II 85	15.52	2.51	3600	14,16.06.94	55
II 94	15.44	3.38	1800	17.06.94	20
II 95	15.73	2.64	1800	17.06.94	35

3. Radial velocities

The radial velocities were determined by means of three methods, as explained below and reported in Table 2. The observed radial velocities derived were transformed to heliocentric values using the observation dates given in Table 1.

(a) A Fourier cross-correlation was applied on the program spectra relative to selected template spectra. As templates, 12 G, K and M stars were selected from the Jacoby et al.'s (1984) library, which have approximately the same spectral resolution (4.5 Å) of the sample spectra. The templates adopted were the ones closest in spectral type to each of the program stars. The spectra of both sample and template stars were normalized and different regions in the spectra were defined in order to give highest peaks of cross-correlation for each considered template. The results obtained with this method are given in Col. 2 of Table 2. The rms of the values derived with each template spectrum is of the order of 15 km s^{-1}. A systematic effect was identified for the coolest stars, since all of them appeared to show lower velocities when compared to the hotter stars of the same cluster and these values were not considered.

(b) Mean shifts between the observed wavelengths of identified absorption lines and laboratory wavelengths were measured (Col. 3 of Table 2). The rms of the values derived is of the order of 15 km s^{-1}.

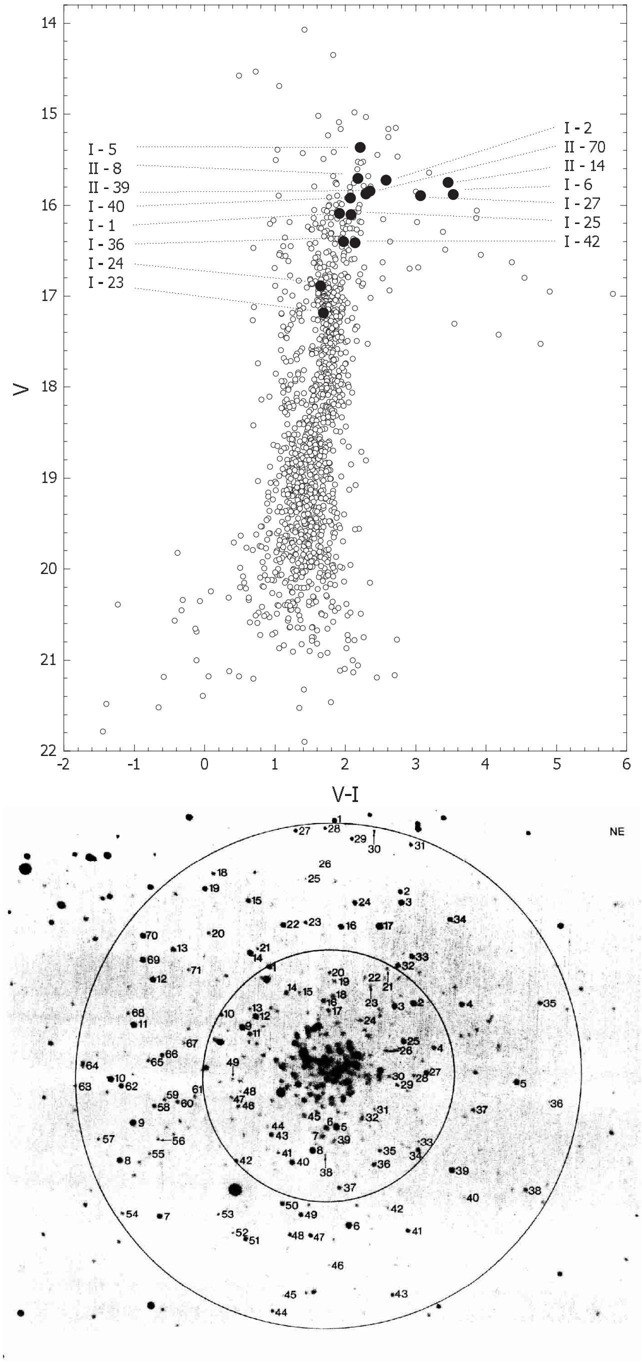

Fig. 1. *Top*: HST Colour-magnitude diagram of NGC 6528, where the observed stars are indicated as filled circles; *Bottom*: a map of the cluster scanned from van den Bergh & Younger (1979).

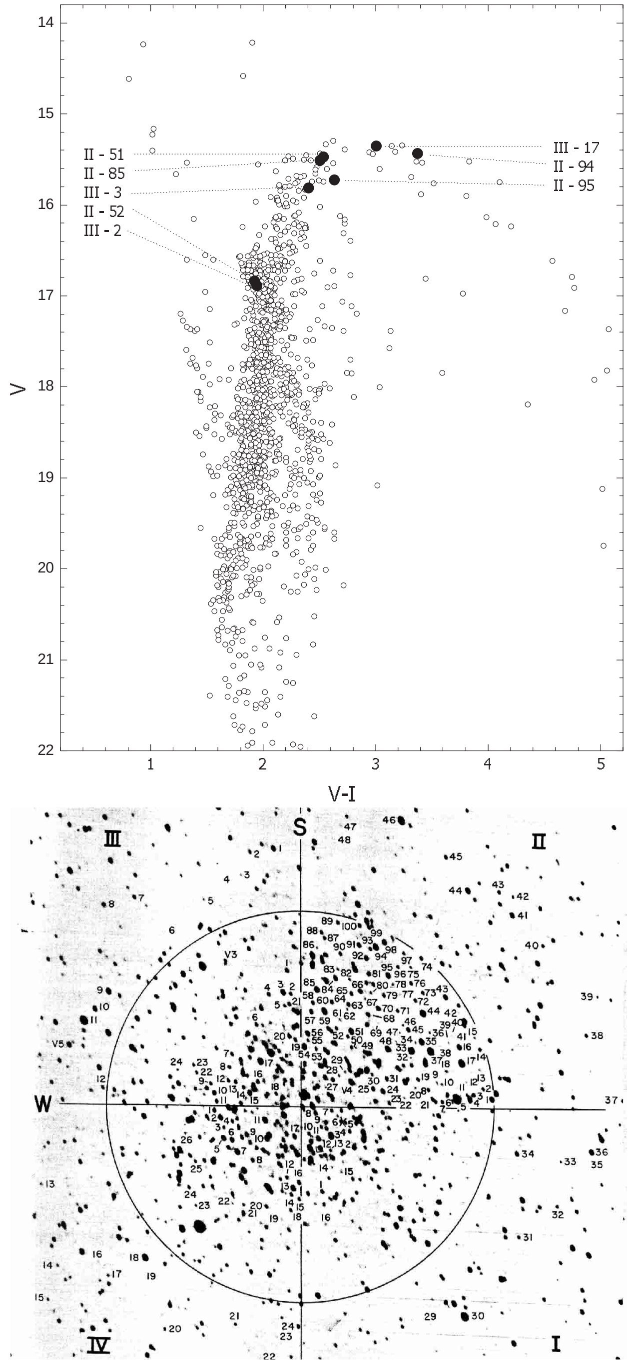

Fig. 2. *Top*: HST Colour-magnitude diagram of NGC 6553, where the observed stars are indicated as filled circles; *Bottom*: a map of the cluster scanned from Hartwick (1975).

(c) the code HALO (Cayrel et al. 1991) derives radial velocities by comparing the observed spectrum to a grid of synthetic spectra, using a cross-correlation technique. The grid of synthetic spectra available (Barbuy et al. 2001) does not contain stars cooler than $T_{\rm eff} < 4000$ K, and for this reason the errors should be higher for velocities of stars cooler than $T_{\rm eff} < 3700$ K in which TiO bands are pronounced.

Histograms of radial velocities of individual stars (coolest stars excluded) corresponding to each method were built. Gaussian curves were fitted to each histogram, from which the radial velocity corresponding to each method was derived, as reported in Table 3 together with values from the literature. An example of this procedure is presented in Fig. 3 for the cross-correlation technique using IRAF. The final radial velocities adopted for the clusters correspond to the mean of the values derived from the three methods.

Table 2. Heliocentric radial velocities v_r (km s^{-1}) obtained with different methods: (a) cross-correlation relative to observed template spectra using IRAF; (b) mean shift in wavelength for a list of selected lines; (c) cross-correlation relative to synthetic spectra using the code HALO (see text).

Star	v_r (km s^{-1}) method (a)	method (b)	method (c)
NGC 6528			
I 1	—	262	174
I 2	224	262	208
I 5	—	261	224
I 6	232	246	225
II 8	289	283	271
II 14	—	264	227
I 23	221	251	—
I 24	238	220	202
I 25	265	257	231
I 27	—	237	188
I 36	244	249	229
II 39	30	17	7
I 40	246	236	244
I 42	197	235	212
II 70	230	263	—
NGC 6553			
III 2	−2	−7	−25
III 3	5	17	18
III 17	3	8	−19
II 51	—	60	—
II 52	−16	−28	−33
II 85	35	56	−4
II 94	−42	−56	−63
II 95	11	−12	−9

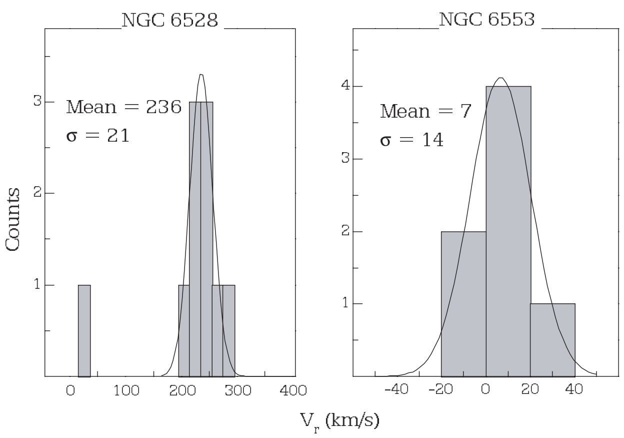

Fig. 3. Histograms of radial velocities obtained for the stars with the cross-correlation technique using IRAF, where the Gaussian fits are presented. The deviant point in the histogram of NGC 6528 is the star II 39, which is probably a non-member.

4. Stellar parameters

4.1. Temperatures

The effective temperatures were estimated from $B-V$, $V-I$, $V-K$ and $J-K$ colours, based on the colour vs. $T_{\rm eff}$ calibrations by Bessell et al. (1998), which in turn are based on NMARCS models by Plez et al. (1992) and their grid extensions. These effective temperatures are listed in Table 5. V and I colours were obtained with the Hubble Space Telescope (Ortolani et al. 1995) and J and K colours were obtained with the detector IRAC2 at the 2.2 m telescope of ESO (Guarnieri et al. 1998).

For NGC 6528 the colour excesses adopted were $E(V{-}I) = 0.68$ and $E(B{-}V) = 0.52$ (Barbuy et al. 1998). For NGC 6553 $E(V{-}I) = 0.95$ and $E(B{-}V) = 0.7$ were adopted (Guarnieri et al. 1998). The $V-K$ and $J-K$ colours were dereddened assuming $E(V{-}K)/E(B{-}V) = 2.744$ and $E(J{-}K)/E(B{-}V) = 0.527$ (Rieke & Lebofsky 1985).

An independent method for the derivation of temperatures was based on calibrations of equivalent widths of TiO bands. The indices as defined in Table 4 were measured on the grid of synthetic spectra by Schiavon & Barbuy (1999) in the range of parameters $3000 \le T_{\rm eff} \le 5000$ K, $-0.5 \le \log g \le 2.5$ and [Fe/H] $= -0.3$. These indices are shown in Fig. 4 for a resolution of $\Delta\lambda = 8$ Å. Polynomial curves of the form $T_{\rm eff} = f(W(\rm TiO))$ were derived and applied to the indices measured in the sample stars. The TiO indices are strongly sensitive to temperature for $T_{\rm eff} \le 3800$ K as illustrated in Fig. 5. For $T_{\rm eff} \ge 4000$ K a degeneracy appears due to the fact that TiO bands are not present at these higher temperatures.

A more general polynomial of the form $\log W(\rm TiO) = (a + b\log T_{\rm eff} + c\log g + d[\rm Fe/H] + e(\log T_{\rm eff})^2 + f\,[\rm Fe/H]^2 + g\,[\rm Fe/H]\log T_{\rm eff})$, valid in the range $2500 \le T_{\rm eff} \le 5000$ K, $-0.5 \le \log g \le 2.5$ and $-0.5 \le$ Fe/H ≤ 0 was derived. The coefficients of the formula above are

Table 3. Radial velocities of NGC 6528 and NGC 6553 given in the literature and values derived in the present work, for which the standard deviation values obtained with the Gaussian fits are indicated in parentheses.

v_r (km s^{-1}) NGC 6528	NGC 6553	Reference
218	6.4	1, 2
164.8	−24.5	3
208	48	4
212	8.4	5
189	—	6
160	−5	7
143	−12	8
236 (21)	7 (14)	9
248 (11)	1 (16)	10
217 (9)	−10 (13)	11

References to Table: 1) Barbuy et al. (1999); 2) Barbuy (2000); 3) Harris (1996); 4) Minniti (1995) (mean values excluding non-member stars); 5) Rutledge et al. (1997); 6) Armandroff & Zinn (1988); 7) Zinn & West (1984); 8) Zinn (1985); 9) present paper (cross-correlation method with IRAF); 10) present paper (mean wavelength shift with IRAF); 11) present paper (code HALO by a cross-correlation method).

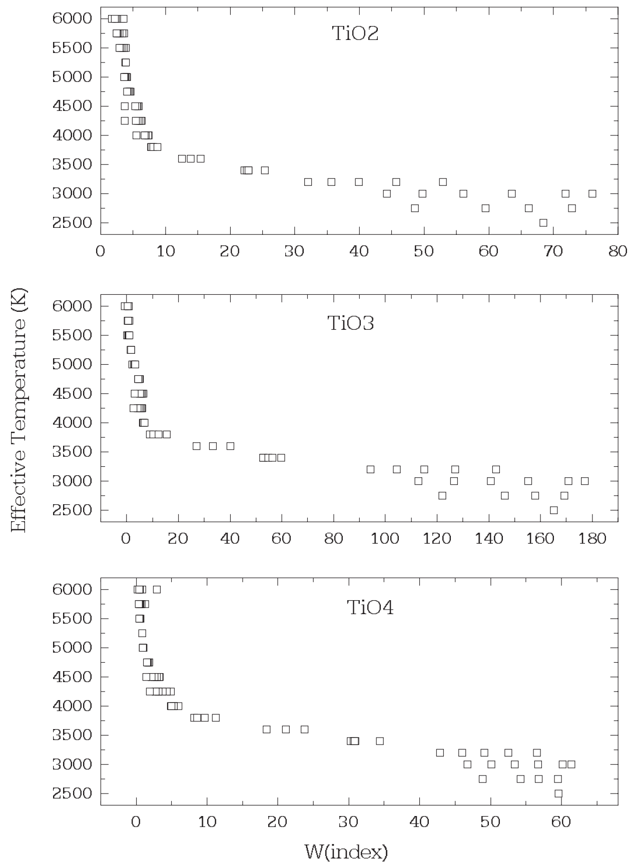

Fig. 4. TiO indices measured on the synthetic spectra as a function of effective temperatures. These measurements correspond to spectra convolved with $FWHM = 8$ Å.

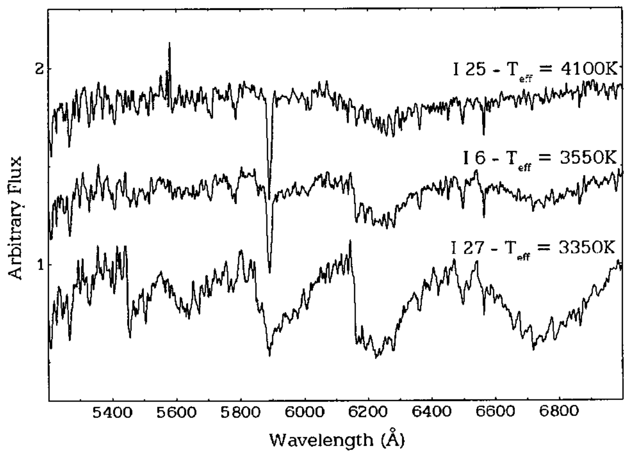

Fig. 5. Spectra of three individual stars of NGC 6528 with different temperatures. It is clear that the $T_{\rm eff} = 3350$ K star has more pronounced TiO molecular bands with respect to the $T_{\rm eff} = 4100$ K one.

shown in Table 6 for convolutions of $\Delta\lambda(FWHM) = 4$ Å and 8 Å.

The temperatures obtained and final values adopted are reported in Table 5. Photometric temperatures were adopted for stars for which the TiO temperature $T_{\rm TiO} \geq 3800$ K, whereas for stars with $T_{\rm TiO} < 3800$ K the mean of TiO temperatures were adopted.

Table 4. TiO indices used in the derivation of effective temperatures. The definition of these indices is such as to avoid regions of strong telluric lines.

Index	Blue continuum	Bandpass	Red continuum
TiO_2	6033.6-6050.6	6300.0-6455.0	6525.0-6538.0
TiO_3	6525.0-6539.0	6617.6-6860.0	7036.0-7046.6
TiO_4	7036.0-7046.6	7053.0-7163.0	7534.2-7546.8

Table 5. Effective temperatures based on calibrations of $B-V$, $V-I$, $V-K$ and $J-K$ colours (Cols. 2 to 5) and TiO indices (Cols. 6 to 8), and final values adopted. The discrepancy between the photometric and spectroscopic effective temperatures of II-51 might be explained by observations in different phases of the light curve of this probable red variable.

	Effective Temperatures (K)							
Star	$V-I$	$B-V$	$J-K$	$V-K$	TiO_2	TiO_3	TiO_4	Final
NGC 6528								
I 1	4305	4449	—	—	—	—	—	4400
I 2	3673	3883	—	—	3922	3698	3506	3700
I 5	—	—	—	—	3468	3053	—	3250
I 6	3451	3890	—	—	3612	3585	3405	3550
II 8	3963	3992	—	—	3776	4049	3789	3950
II 14	—	—	—	—	3468	3053	—	3250
I 23	4783	4770	—	—	—	—	—	4800
I 24	4883	4707	—	—	—	—	—	4800
I 25	4074	4092	—	—	—	—	—	4100
I 27	—	—	—	—	3673	—	3001	3350
I 36	4218	4216	—	—	—	—	—	4200
I 40	4084	4137	—	—	—	—	—	4100
I 42	3999	4149	—	—	—	—	—	4050
II 70	3810	3951	—	—	—	—	—	3900
NGC 6553								
III 2	4828	—	4809	4559	—	3842	3776	3800
III 3	4015	—	4221	3939	3782	3800	3775	3800
III 17	3606	—	3966	3611	4052	3698	3503	3750
II 51	3885	—	3966	3856	3281	3206	—	3250
II 52	—	—	—	—	4241	3703	3752	3900
II 85	3912	—	4140	3835	—	—	—	3950
II 94	3506	—	3984	3432	4802	4408	3832	3650
II 95	—	—	—	—	—	—	—	6500

4.2. Gravities

Gravities were derived using the classical relation $\log g_* = 4.44 + 4 \log T_*/T_\odot + 0.4(M_{\rm bol} - M_{\rm bol\odot}) + \log M_*/M_\odot$, adopting $T_\odot = 5770$ K, $M_* = 0.8\ M_\odot$ and $M_{\rm bol\odot} = 4.74$ cf. Bessell et al. (1998). For deriving $M_{\rm bol*}$ we used the distance modulus adopting a total extinction $A_V = 2.43$ for NGC 6553 and $A_V = 1.8$ for NGC 6528 (Barbuy et al. 1998). The bolometric magnitude corrections were taken from Bessell et al. (1998).

Table 6. Coefficients of polynomial fits of $W(\mathrm{TiO})$ indices as a function of stellar parameters for $2500 \leq T_{\mathrm{eff}} \leq 5000$ K, $-0.5 \leq \log g \leq 2.5$ and $-0.5 \leq [\mathrm{Fe/H}] \leq 0$.

Coefficient	TiO2		TiO3		TiO4	
$\Delta\lambda$	4 Å	8 Å	4 Å	8 Å	4 Å	8 Å
a (constant)	81.49	81.89	55.70	56.51	−175.11	−158.38
b ($\log(T_{\mathrm{eff}})$)	−39.44	−39.71	−22.93	−23.53	105.33	95.92
c ($\log g$)	−0.04	−0.04	−0.04	−0.05	−0.06	−0.06
d ([Fe/H])	9.28	9.14	3.40	3.21	−7.42	−5.10
e ($\log(T_{\mathrm{eff}})^2$)	4.75	4.79	2.17	2.27	−15.66	−14.34
f ($[\mathrm{Fe/H}]^2$)	−0.47	−0.45	−0.40	−0.38	−0.45	−0.08
g ([Fe/H]$\times$ $\log(T_{\mathrm{eff}})$)	−2.56	−2.51	−0.87	−0.82	2.16	1.54
r^2	0.92	0.92	0.90	0.90	0.97	0.96

The resulting $M_{\mathrm{bol}*}$ and gravities are given in Table 7. Taking into consideration the errors due to uncertainties in T_{eff} and M_{bol} the final error in $\log g$ is estimated to be of ±0.5 dex.

4.3. Metallicities

Spectrum synthesis calculations were used to fit the observed spectra. The calculations of synthetic spectra were carried out using the code described in Barbuy et al. (2000) where molecular lines of MgH $A^2\Pi$–$X^2\Sigma$, CH $A^2\Delta$–$X^2\Pi$, CN $A^2\Pi$–$X^2\Sigma$, C_2 Swan $A^3\Pi$–$X^3\Pi$ and TiO α $C^3\Delta$–$X^3\Delta$, γ $A^3\Phi$–$X^3\Delta$ and γ' $B^3\Pi$–$X^3\Delta$ systems are taken into account.

For atomic lines the laboratory oscillator strengths by Fuhr et al. (1988), Martin et al. (1988), Wiese et al. (1969), and laboratory values compiled by McWilliam & Rich (1994) were adopted whenever available, otherwise they were taken from fits to the solar spectrum (see discussion in Barbuy et al. 1999).

ATLAS9 and NMARCS models were employed. A grid of models using the ATLAS9 code (Kurúcz 1993) was created adopting a mixing length parameter $\alpha = 0.5$ (see Barbuy et al. 2001). NMARCS photospheric models for giants by Plez et al. (1992) and their unpublished extended grids were employed (see more details in Schiavon & Barbuy 1999).

The metallicities were obtained based on two methods, both using synthetic spectra:

(i) The observed spectra were compared to synthetic spectra in the range $\lambda\lambda$ 5000–7500 Å. The metallicities were estimated by interpolating between synthetic spectra of [Fe/H] = 0.0, −0.3, −0.5 and −0.6, in all cases assuming [Mg/Fe] = +0.3, and the temperatures and gravities determined in Sects. 4.1 and 4.2.

(ii) Comparisons with a grid of synthetic spectra in the wavelength region $\lambda\lambda$ 4600–5600 Å, using the differences method as described in Cayrel et al. (1991) and Barbuy et al. (2001), are carried out. In this method, the observed spectrum is divided by a reference synthetic spectrum. The resulting signal can be expressed as a linear combination of variations in temperature, gravity and metallicity. In conjunction with the grid of synthetic spectra, it is possible to establish the differences in T_{eff}, $\log g$ and [Fe/H] between the program star and the reference synthetic spectrum through a perturbation method. The grid covers the range $4000 \leq T_{\mathrm{eff}} \leq 7000$ K, $0.0 \leq \log g \leq 5.0$, $-3.0 \leq [\mathrm{Fe/H}] \leq +0.3$, and [Mg/Fe] = 0.0 and +0.4. Figure 6 shows the fit to NGC 6528 I-1.

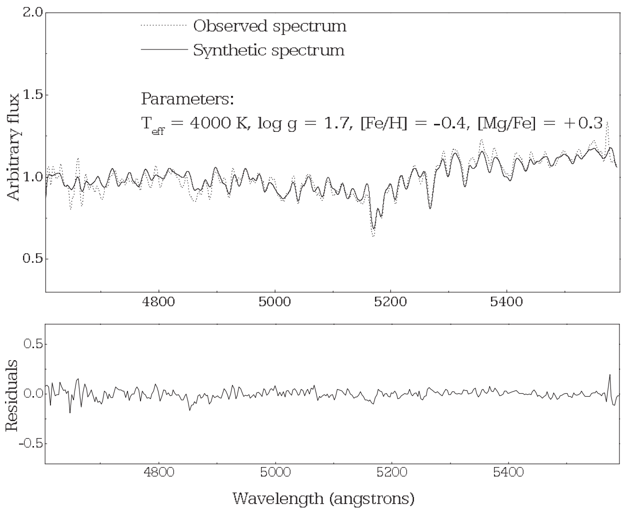

Fig. 6. Analysis of NGC 6528 I-1 employing the code HALO: *Top:* observed spectrum (dotted line) and synthetic spectrum (solid line) computed with $T_{\mathrm{eff}} = 4400$ K, $\log g = 1.7$, [Fe/H] = −0.4 and [Mg/Fe] = +0.30 ($FWHM = 8$ Å); *Bottom:* residual flux relative to the template synthetic spectrum.

In Table 7 are listed the temperatures, gravities, [Fe/H] and [Mg/Fe] obtained with methods (i) and (ii). Note that method (ii) tends to give lower metallicities relative to method (i). This may be due to limitations of the grid of synthetic spectra, which is being extended to cover wider ranges of parameters.

The stars NGC 6528 I-5, NGC 6553 III-2 and II-95 are probable non-members, given that their atmospheric parameters are incompatible with their location in the Colour-Magnitude Diagrams of the clusters. The star II-51 appears to be too cool (Table 7) with respect to its CMD locus (Fig. 2). However, considering that it could be a red variable, this star is tentatively classified as a possible member.

Mean metallicities of [Fe/H] = −0.5 for NGC 6528 and [Fe/H] = −0.7 for NGC 6553 were estimated from Gaussian fits to the histograms of metallicities given in Table 7 (typical standard deviations are of 0.2 dex). These metallicities, together with the magnesium excess of [Mg/Fe] $\approx$ +0.3, and assuming that all other α elements show an excess of +0.3 dex relative to iron, result in overall metallicities of $[Z/Z_{\odot}] = -0.25$ and -0.45 for NGC 6528 and NGC 6553 respectively.

Table 7. Bolometric magnitudes, atmospheric parameters and method employed (see Sect. 4.3). $M_{\rm bol}$ values were not reported for probable non-member stars.

Star	$M_{\rm bol}$	$T_{\rm eff}$	$\log g$	[Fe/H]	[Mg/Fe]	Method
NGC 6528						
I 1	−0.8	4400	1.7	−0.4	0.3	i
		4400	1.7	−0.4	0.3	ii
I 2	−2.0	3700	0.9	−0.5	0.3	i
I 5	–	3250	0.7	−0.5	0.3	i
I 6	−3.0	3550	0.4	−0.6	0.3	i
II 8	−1.5	4000	1.2	−0.5	0.3	i
		4000	0.5	−0.6	0.3	ii
II 14	−3.1	3250	0.2	−0.5	0.3	i
I 23	0.6	4800	2.4	0	0.3	i
		4800	2.4	−0.4	0.2	ii
I 24	0.4	4800	2.3	0	0.3	i
		4800	2.3	−0.3	0.1	ii
I 25	−1.0	4100	1.4	−0.6	0.3	i
		4100	1.4	−1.1	0.2	ii
I 27	−2.5	3350	0.5	−0.3	0.3	i
I 36	−0.6	4200	1.7	−0.6	0.3	i
		4250	1.0	−0.8	0.4	ii
I 40	−1.2	4100	1.4	−0.4	0.3	i
		4100	1.4	−0.7	0.3	ii
I 42	−0.8	4050	1.5	−0.4	0.3	i
		4050	1.5	−1.2	0.2	ii
II 70	−1.6	3900	1.1	−0.6	0.3	i
NGC 6553						
III 2	–	3800	2.0	−0.7	0.3	i
III 3	−1.1	3800	1.3	−0.7	0.3	i
III 17	−2.3	3750	0.8	−0.7	0.3	i
II 51	–	3250	0.8	−0.4	0.3	i
II 52	0.6	3900	2.0	−0.6	0.3	i
II 85	−1.5	3950	1.2	−0.6	0.3	i
II 94	−2.7	3650	0.6	−1.1	0.3	i
II 95	–	6500	2.7	−0.4:	–	ii

5. Conclusions

The study of individual stars in globular clusters along their evolutionary stages is of prime importance for an improved understanding of stellar evolution. Low resolution spectroscopy provides a means for the study of a large number of stars. In the present work we have measured radial velocities and estimated metallicities in 23 stars towards the globular clusters NGC 6528 and NGC 6553, which allows us to identify member stars. We also obtained their atmospheric properties to a first approximation. This is an important step before applying efforts to obtain high resolution spectroscopy with 8 m class telescopes. The method presented here is also of interest for last generation multi-object instruments such as VLT-VIMOS.

The stars were analysed by comparisons between their observed spectra and a grid of synthetic spectra. TiO equivalent widths were used to estimate effective temperatures of stars cooler than $T_{\rm eff} \leq 3800$ K and a calibration of equivalent widths of TiO bands as a function of atmospheric parameters is presented.

Mean values of heliocentric radial velocities of $v_{\rm r}$ = 234 km s^{-1} for NGC 6528 and $v_{\rm r}$ = −1 km s^{-1} for NGC 6553 are derived.

Regarding membership, among the 23 stars observed we concluded that 4 of them are probable non-members. These are: NGC 6528 II-39, non-member due to a deviant radial velocity, and NGC 6528 I-5, NGC 6553 III-2 and II-95, non-members due to incompatibilities of atmospheric parameters vs. location in the Colour-Magnitude Diagrams.

NGC 6553 II-51 could be a non-member, or a red variable for which the spectrum was taken during a cool phase.

The basic stellar parameters derived show the interesting result that there is a trend for member giants of NGC 6528 to be more metal-poor than the two Horizontal Branch stars NGC 6528 I-23 and I-24, thus reproducing the discrepancy found between analysis of NGC 6553 giants by Barbuy et al. (1999) and Horizontal Branch stars by Cohen et al. (1999). Given the errors involved in the analysis of low resolution spectra, these results have to be checked with high resolution spectra, and further studies of this discrepancy will be possible only with a homogeneous analysis of stars ranging from the red giant branch to the HB, and also employing different sets of model atmospheres all along the evolutionary sequence.

In summary, we obtained for NGC 6528 and NGC 6553 metallicities of [Fe/H] = -0.5 ± 0.3 and [Fe/H] = $-0.7 \pm$ 0.3. Using [Mg/Fe] $\approx +0.3$, and assuming that other α elements show the same excess of +0.3 dex relative to iron, the results are $[Z/Z_{\odot}] = -0.25$ and -0.45 for NGC 6528 and NGC 6553 respectively.

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