# Refining the true parameters of the open cluster NGC 4852


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## Abstract

NGC 4852 is a moderately compact cluster centered at $\alpha_{2000}$ = 13:00:09 $\delta_{2000}$ = -59:36:48 located near the center of an H$\alpha$ super ring. This cluster forms part of an extended region including young stellar aggregates inside a circle 3º radius where many of them show abundance of emission line stars. In the field of this cluster, two stars that type are known to exist: Wray 15-1039 ("emission object (e?)") and the CD -58:4845 ("emission star B…e"). Still we do not know whether the Be-phase is a transient one or it is just what randomly happens in some hot stars. Anyway, it appears clearly stated that Be may be found even in clusters as old as 70 Myr with a high frequency peak at clusters 25-27 Myr old. A recent photometric survey sets that NGC 4852 is about 200-250 million years old, located at 1.1 kpc from the Sun with a mean E(B - V) = 0.45. Since the presence of potential Be-type stars in the cluster area suggests it may be a very young object instead of a moderately old one, as already proposed, we decided to carry out spectroscopy for 32 selected stars and CCD UBVI photometry for the bright objects in the cluster area. This way, we attempt to clarify their evolutionary status and insert them in the framework of emission stars and open clusters. From our analysis we agree with the cluster distance and reddening earlier found, but we can state the age of NGC 4852 is less than 40 Myr.


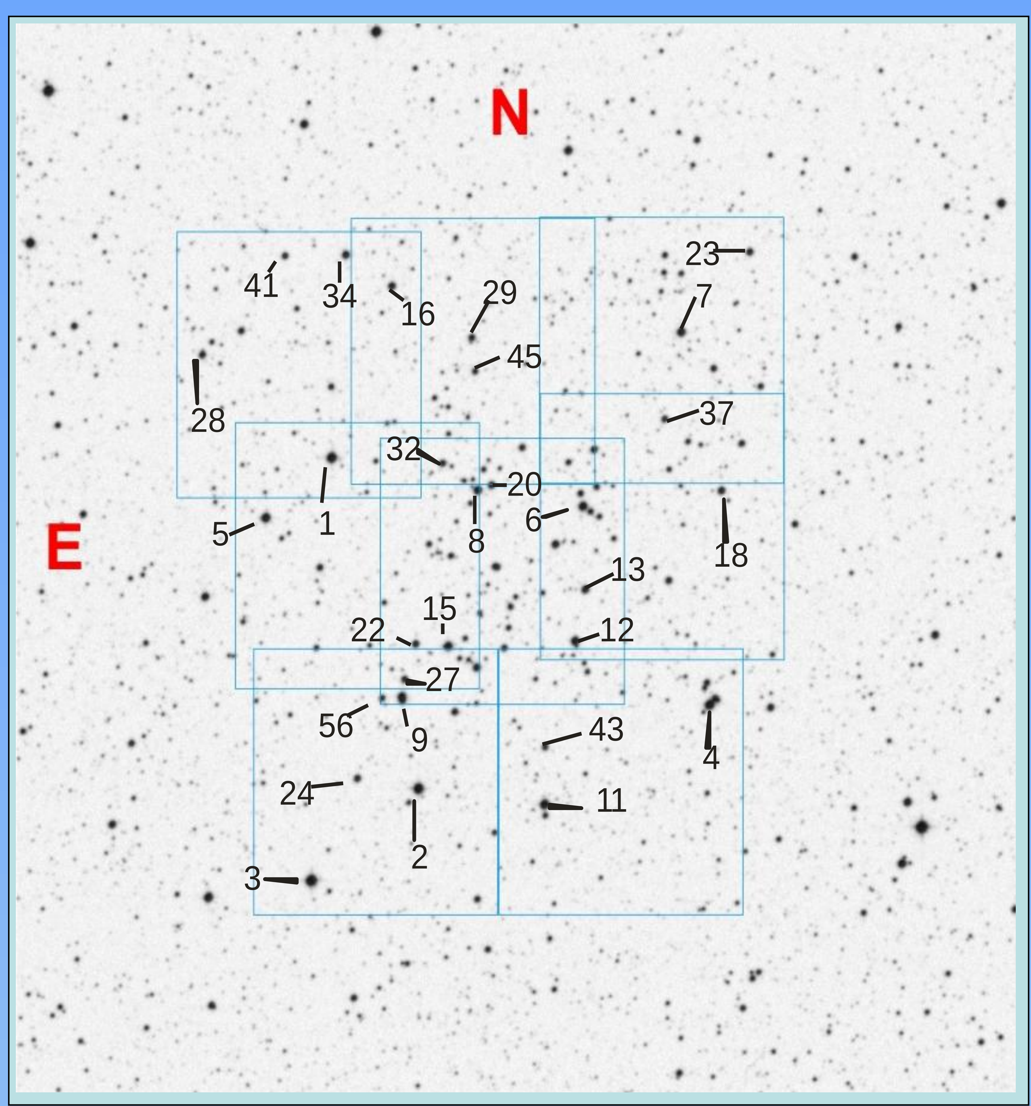


**Figure 1:** Finding chart showing the eight frames (squares) needed to properly match the cluster surface and the star identification (numbers) of stars for which spectral types are now available. North is at top and East at left.

## Data

Spectral data for 32 of the brightest stars in NGC 4852 were collected at the 2.15-m telescope of CASLEO (Argentina) during several observing runs since April 2004 until February 2007. The spectra were obtained with the REOSC DS Cassegrain spectrograph and the Tek 1024 x 1024 detector using a 600 l/mm grating in the first order. Spectra have a wavelength range of 3900-5500 Å, (the traditional spectral region for classification from CaII K to Ḥ lines, allowing precise MK types), 2.5 Å/pixel dispersion (1800 resolution) and were reduced using standard procedures with IRAF. For classification purpose we used MK standard stars taken with the same configuration at CASLEO and the Digital Spectra Classification of R.O. Gray and the MK Standard.

CCD observations in the UBVI system were carried out in eight fields covering the central region of the open cluster NGC 4852 on the nights of April 4, 6 and 7, 2005, and May 17 2007 at the Complejo Astronómico El Leoncito, CASLEO, Argentina, using the 2.15-m telescope equipped with a CCD ROPER 1300B, 1340x1300 and 0.226"/pix scale, covering 4.2 arcmin on a side. Exposure times were of 60 to 120 seconds in U; 60 seconds in B; 60 to 4 seconds in V , and 4 to 40 seconds in I.

Typical seeing values at CASLEO ranged from 1.3 to 2.1arcsec. Instrumental magnitudes were obtained by means of the point spread function (PSF) fitting using the DAOPHOT (Stetson 1987) package within IRAF. The cluster photometry was put into the UBVI system using the Carraro et al. (2005) stars found in common with ours as secondary standards. The external precision of our photometry (by comparison with Carraro et al. common stars) is of the order of 0.06 in V, 0.07, in B-V and 0.08 in U-B.

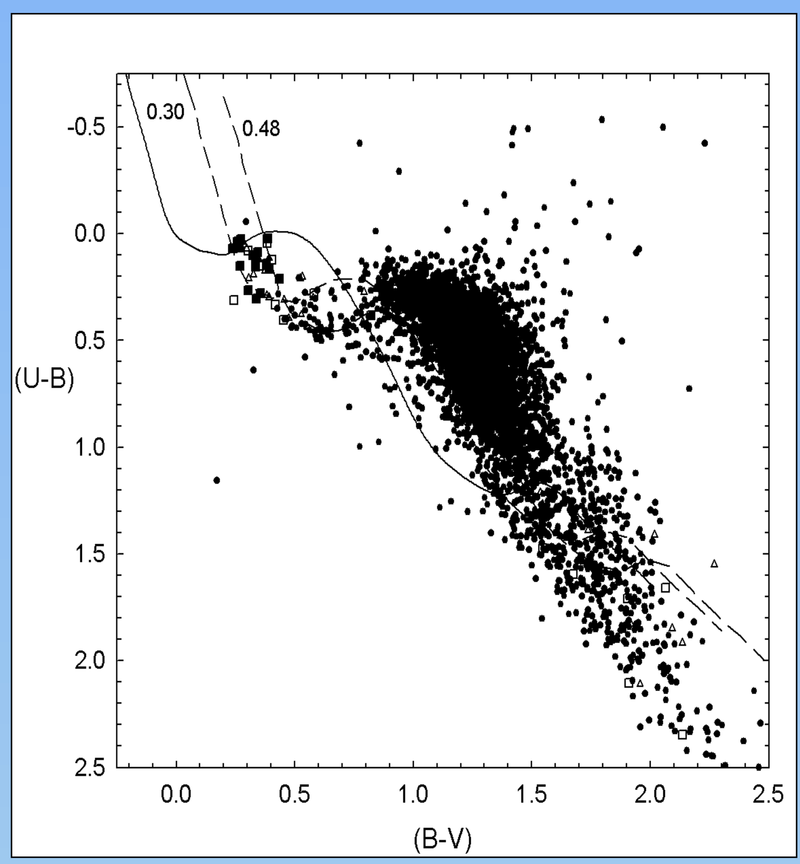


**Figure 2**

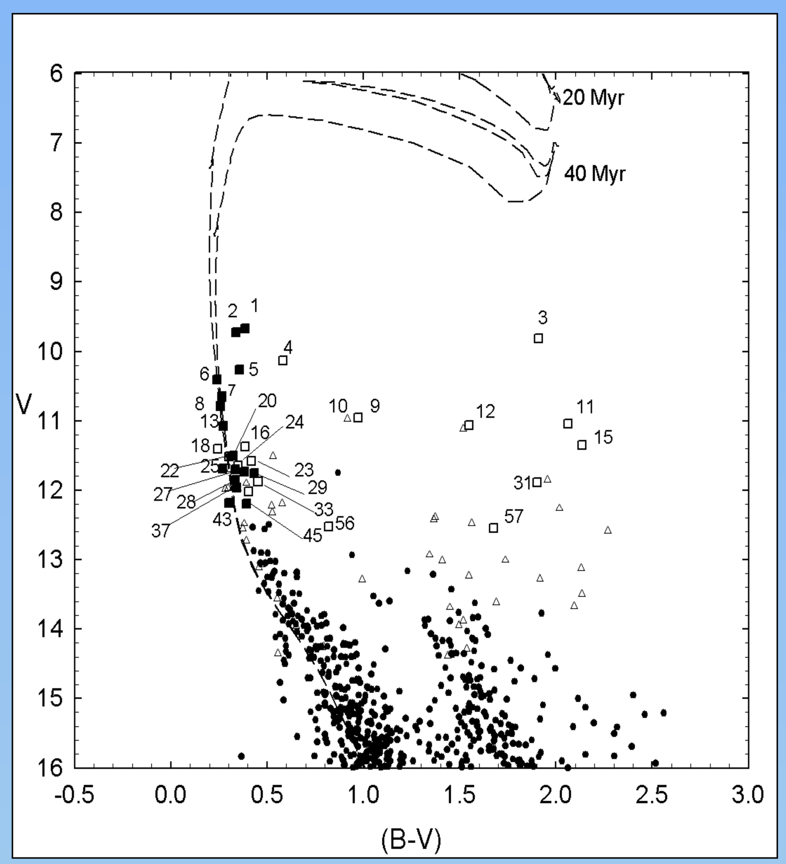


**Figure 3**

**Figure 2 and Figure 3:** the color-color (TCD) and color-magnitude (CMD) diagrams. Open triangles indicate stars for which new photometry is available while open [non-members] and filled [probable members] squares are use to denote stars with new photometry and spectroscopy. Numbers in Fig. 2 indicates extreme E(B-V) values. For comparison purposes, we show in Fig. 3 the number of each star as indicated in Table 1. The rest of stars (big dots) belong to Carraro et al. (2005). Both diagrams confirm that the severe cut-off at V =12 in Carraro et al. data meant the loss of many blue stars belonging to the upper cluster main sequence.

## Analysis

The ZAMS of Schmidt-Kaler (1982) -solid line- is shown in the TCD (Figure 2) in its normal position. The ZAMS (long-dashed lines) was also displaced to bracket the maximum and minimum reddening values within which the probable cluster members are found. Our inspection indicates that NGC 4852 is characterized by mean color excesses E(B-V) = 0.48± 0.03 and E(U-B) = 0.30 ± 0.03. It is worth mentioning that cluster stars are affected by the presence of intra-cluster material that produces moderate color spread around the mean. Similarly, the CMD (Figure 3) demonstrate dramatically the impact of the loss of the brightest stars in Carraro et al. (2005) as we can now trace clearly the upper main sequence up to three magnitudes above the previous limit (V=12) found by them. In the estimation of the cluster distance we had no reason to change the former value given by Carraro et al, that is $V_0$-Mv = 10.20 ± 0.20. Our ZAMS fitting is shown by a solid line in the CMD.

This modulus yields a distance of d = 1.1 ± 0.2 kpc, assuming a normal reddening law (R = 3.1).

Table 1 gives the spectral classification of the 32 stars. It is interesting to note that about 2/3 of the sample is mostly composed by middle and late B-types. We take advantage of counting on such a large amount of spectral types to improve the cluster distance and other parameters. Each star was then de-reddened using the relation between spectral types and color indices as given in Schmidt-Kaler (1982). Absolute magnitudes according to the spectral classification were also taken from the same author (see Giorgi et al. 2005). By comparison of spectral types and from the analysis of their simultaneous positions in the CMD and TCD, we could give a membership to each of these stars [filled squares for probable members and open squares for non members]. The procedure yielded that sixteen out of thirty two stars with spectral classification have a chance to be probable members of NGC 4852. In particular, cluster members are as early as B2 but in the mean are around B7.

The statistic of the table numbers gives the following result: E(B-V)= 0.45 ± 0.08, $V_0$-Mv=10.4 ± 0.4. Assuming a normal reddening law (R=3.1) the distance of NGC 4852 is d = 1.2 ± 0.2 kpc. Within the uncertainty level both, the photometric and spectroscopic distances, are fully coincident.

Previous estimates of spectral types were found for the star Wray 15-1039 (Nº 18) which was indicated as an "emission object (e?)" and is now a confirmed Be-type star (B5Ve). The star Nº 5 (CD -58:4845) was indicated as "emission star B…e"; it was also classified B2V, according to the Michigan Catalogue. After our classification it is a B2Ve. The star No. 1 (HD 112852) was classified B8/B9II (Buscombe Catalogue); it is now a B7III. Star No 2 (HD 112825) was classified B1/2 IV/5V with emission reported in the Michigan Catalogue and as a B1.5IVe by Jascheck (1978); after our survey this star becomes a B2Ve (the difference can be due to some undetected variable character of the emission feature. Regarding the cluster distance, star Nº 18 is located beyond NGC 4852 as given in the last column of the Table 1. Therefore two out of three emission stars detected in the present sample become probable cluster members.

The cluster age was derived by superposing the isochrones set from Girardi et al. (2000) computed with mass loss, overshooting and solar metal content. There is no single isochrone curve able to properly match the cluster sequence as usual in young clusters. Accordingly, we superposed in the CMD two age limits, for 20 and 40 Myr, indicated by long dashed-lines. The new age result agrees very well with the presence of two Be-type stars instead of the former one of 200 Myr stated by Carraro et al (2005). In fact, this type of stars are expected to show a maximum of occurrence in clusters around 30 Myr old as stated by (Fabregat & Torrejón, 1999; Zorec & Briot 1997, Mathew et al. 2008).

Looking at the data table there are some other stars, chiefly giant stars of late type sharing a similar distance with cluster members. However they do not have any parental relation with NGC 4852 because the isochrones fitting (Girardi et al. 2000) suggests that the cluster is between 20 and 40 Myr old, making thus impossible that such evolved stars become cluster members.

Finally, the spectroscopy suggests the presence of three star groups in the area of NGC 4852:
A first one including early stars (B and Be type) with similar distances in good agreement with the cluster distance derived from the ZAMS fitting. Therefore, we conclude they are all likely cluster members with just one exception.

A second group of main sequence stars (mostly of A-F types) located at distances ranging from 0.1 to 0.8 kpc approximately. They are, obviously, foreground stars. A third group of K-M giant stars. With just one nearby giant, the rest of them are all background objects with distances from 1.0 to about 4.0 kpc.

**Table 1:** Spectral classification and distance for 32 stars. Notes: (pm), probable member; (nm), non member .

| Nº | TE | Mv | $(B-V)_0$ | $(U-B)_0$ | E(B-V) | E(U-B) | $V_0$-Mv | d[pc] | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 1 | B7III | -2.20 | -0.17 | -0.44 | 0.56 | 0.46 | 10.15 | 1070 | **pm** |
| 2 | B2Ve | -2.45 | -0.24 | -0.84 | 0.58 | 1.14 | 10.39 | 1195 | **pm** |
| 3 | K2.5III | 0.40 | 1.20 | 1.28 | 0.71 | 0.82 | 7.22 | 278 | nm |
| 4 | F0V | 2.70 | 0.30 | 0.03 | 0.28 | 0.25 | 6.56 | 205 | nm |
| 5 | B2Ve | -2.45 | -0.24 | -0.84 | 0.60 | 1.12 | 10.86 | 1487 | **pm** |
| 6 | B7Vp | -0.60 | -0.13 | -0.43 | 0.37 | 0.50 | 9.86 | 936 | **pm** |
| 7 | B8Vp | -0.25 | -0.11 | -0.34 | 0.38 | 0.40 | 9.74 | 886 | **pm** |
| 8 | B7V | -0.60 | -0.13 | -0.43 | 0.39 | 0.47 | 10.18 | 1087 | **pm** |
| 9 | F6V | 3.60 | 0.44 | 0.00 | 0.53 | - | 5.70 | 138 | nm |
| 11 | M4III | -0.50 | 1.62 | 1.73 | 0.44 | 0.00 | 10.17 | 1079 | nm |
| 12 | K0III | 0.70 | 1.00 | 0.84 | 0.55 | 0.63 | 8.67 | 542 | nm |
| 13 | B7Vp | -0.60 | -0.13 | -0.43 | 0.40 | 0.46 | 10.43 | 1220 | **pm** |
| 15 | M2III | -0.60 | 1.60 | 1.89 | 0.54 | 0.46 | 10.30 | 1146 | nm |
| 16 | B3Vp | -1.60 | -0.20 | -0.71 | 0.58 | 0.76 | 11.16 | 1703 | nm |
| 18 | B5Ve | -1.20 | -0.17 | -0.58 | 0.41 | 0.89 | 11.32 | 1839 | nm |
| 20 | B8Vp | -0.25 | -0.11 | -0.34 | 0.43 | 0.44 | 10.41 | 1207 | **pm** |
| 22 | B5Vp | -1.20 | -0.17 | -0.58 | 0.47 | 0.66 | 11.25 | 1779 | nm |
| 23 | A5Vp | 1.95 | 0.15 | 0.10 | 0.27 | 0.23 | 8.80 | 575 | nm |
| 24 | B3V | -1.60 | -0.20 | -0.71 | 0.55 | 0.86 | 11.55 | 2038 | nm |
| 25 | B9V | 0.20 | -0.07 | -0.20 | 0.34 | 0.35 | 10.45 | 1228 | **pm** |
| 27 | B8V | -0.25 | -0.11 | -0.34 | 0.45 | 0.45 | 10.57 | 1298 | **pm** |
| 28 | B9V | 0.20 | -0.07 | -0.20 | 0.45 | 0.34 | 10.14 | 1065 | **pm** |
| 29 | B9V | 0.20 | -0.07 | -0.20 | 0.50 | 0.41 | 9.99 | 996 | **pm** |
| 32 | B8V | -0.25 | -0.11 | -0.34 | 0.45 | 0.49 | 10.72 | 1395 | **pm** |
| 33 | A1V | 1.00 | 0.01 | 0.02 | 0.44 | 0.38 | 9.51 | 797 | nm |
| 34 | G8III | 0.80 | 0.94 | 0.70 | 0.96 | 1.01 | 8.10 | 417 | nm |
| 37 | B8V | -0.25 | -0.11 | -0.34 | 0.45 | 0.43 | 10.81 | 1451 | **pm** |
| 41 | B7III | -1.50 | -0.13 | -0.44 | 0.53 | 0.56 | 11.86 | 2360 | nm |
| 43 | B9V | 0.20 | -0.07 | -0.20 | 0.37 | 0.46 | 10.83 | 1465 | **pm** |
| 45 | B9V | 0.20 | -0.07 | -0.20 | 0.46 | 0.36 | 10.57 | 1298 | **pm** |
| 56 | F6V | 3.60 | 0.44 | 0.00 | 0.38 | 0.38 | 7.74 | 353 | nm |
| 57 | M2III | -0.60 | 1.60 | 1.89 | 0.08 | -0.30 | 12.91 | 3817 | nm |

Column 1: star number; column 2: spectral type derived in this article; columns 3, 4 and 5 are the absolute magnitude and intrinsic colors from Schmidt-Kaler (1982); column 6 and 7 report the derived color excesses –see text; columns 8 and 9 report distance modulus and distance in pc.

## Final remarks

The spectro-photometric analysis carried out in NGC 4852 allowed to greatly improve its main parameters: membership, color excess, distance and age by collecting information of bright members. Membership of the bright stars has been obtained, color excess and distance are confirmed by our analysis. However, the age has changed drastically and connect this cluster with the mean properties expected for clusters having emission stars.

In brief:

•Photometry of the brightest stars and spectroscopy for most of them has been done for the first time.

•The fitting of isochrones from Girardi et al. (2000) to the upper main sequence stars yields a cluster age ranging from 20 to 40 Myr; therefore the cluster is younger than early assumed.

•New spectral types confirm emission features in three stars in full agreement with the cluster age.

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