Astron. Astrophys. 300, 126-127 (1995)

ASTRONOMY
AND
ASTROPHYSICS

*Research Note*

# Spectroscopic observations of the young open cluster NGC 366

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Received 21 December 1994 / Accepted 26 January 1995

**Abstract.** In this note we give the spectral classification for ten of the brightest stars in the field of the young open cluster NGC 366. This allows us to obtain a reliable estimate of the individual reddenings, the distance and age of the cluster. One of the stars shows an emission line spectrum, and is classified as Be. We confirm NGC 366 to be a very young cluster (age $\sim 10^7$ yr) and we obtain a slightly smaller distance compared to that given by Phelps & Janes (1994).

**Key words:** open clusters and associations: individual: NGC 366 – stars: distances

## 1. Introduction

The investigation of both stellar and diffuse content of young galactic clusters gives hints on modes of star formation in aggregates. In this framework, the capability to give correlations between the mass in stars and in residual gas in recently formed clusters stands on reliable determination of cluster and gas mother–cloud distances (see discussion in Battinelli et al. 1992). To accomplish this task, it is of course worth to rely on spectroscopic observations of stars in the cluster, in order to get spectral types useful to state membership and to evaluate the cluster spectroscopic parallax.

## 2. Observational data

Using the photometric data made available to us by Phelps & Janes (1994, hereafter PJ) we identified all stars brighter than V=14 mag within their estimated cluster radius (2.38 arcmin). In the allocated observational time we could obtain spectroscopic observations for ten stars in this set. These stars are shown in Fig. 1, where the star numbers were assigned following the order of increasing apparent visual magnitude.

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We used the 182 cm telescope of the Asiago Observatory, equipped with a Boller and Chivens spectrograph and a Thompson TH7882 CCD detector (pixel size 23 $\mu$m). Due to the relative faintness of the stars we used a slit width of 2.5" and a dispersion of 170 Å/mm, which yields a resolution of $\sim$10 Å. All the data reduction was performed using standard tasks of the IRAF package at the Asiago Observatory and at our home Institutions.

The spectral classification was made by comparison with the stellar spectrophotometric library by Jacoby et al. (1984), properly degrading its high resolution (3 Å) to that of our spectra.

## 3. Results

Spectral types have been identified with an uncertainty of one subtype and all the observed stars result to be confidently assigned to class III (the quality of our data and the spectral class resolution of Jacoby's library allowed us to distinguish among just luminosity classes V, III and I). In Table 1 we give for each star: the star number on our finding chart, the PJ identification number, and U,B,V photometric data, as well as our determination of spectral type.

Table 1 shows that all the observed stars are of spectral type B, and therefore rather young, the brightest being also of earlier spectral type: therefore it is very probable that they are members of the cluster. The stars 12 and 15 resulted to be exposed not enough to derive a good spectral type for them. We noted that H$\beta$ and H$\gamma$ lines in the spectrum of star 15 are partially filled in, so it must be regarded as a Be type star. Spectral types together with the photometric data permit to obtain for each star the reddening value, the extinction and finally its distance modulus. The $M_V$–spectral type and intrinsic colour–spectral type relations were taken from Schmidt-Kaler (1965, 1982); in accordance with PJ we assume a ratio 3.1 between the visual absorption $A_V$ and the reddening value E(B-V). Incidentally, we note that the average ratio E(U-B)/E(B-V) for our stars is 0.72, very similar to the value 0.69 adopted by PJ. The results are collected in Table 2: column 1 gives the star identification number, column 2 and 3 the B-V and U-B colour excesses, respectively, column 4 the

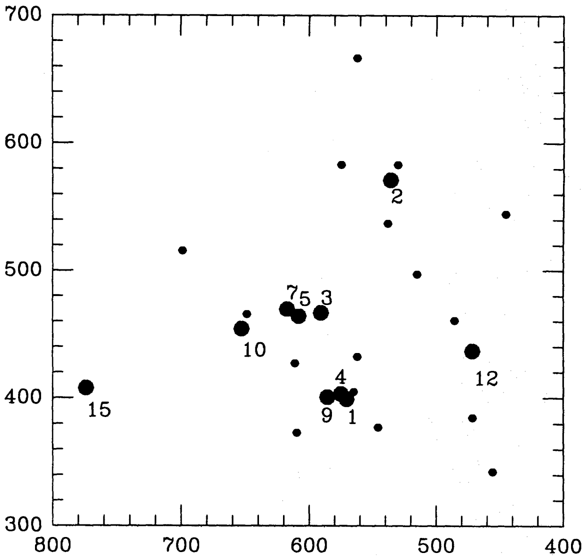


**Fig. 1.** Identification map of our observed stars (larger numbered dots) in the PJ CCD field. One pixel corresponds to 0.68 arcsec

**Table 1.** Photometric data and spectral types

| *Star* | *PJ* | *V* | $B-V$ | $U-B$ | *SP* |
|---|---|---|---|---|---|
| 1 | 586 | 11.54 | 1.10 | 0.13 | *B*1 |
| 2 | 536 | 11.64 | 1.12 | 0.13 | *B*1 |
| 3 | 617 | 11.95 | 1.09 | 0.06 | *B*1 |
| 4 | 592 | 12.23 | 1.12 | 0.11 | *B*1 |
| 5 | 645 | 12.32 | 1.00 | 0.06 | *B*3 |
| 7 | 656 | 13.14 | 1.00 | 0.07 | *B*3 |
| 9 | 609 | 13.51 | 1.23 | 0.28 | *B*3 |
| 10 | 698 | 13.70 | 1.04 | 0.08 | *B*3 |
| 12 | 430 | 13.85 | 0.84 | 0.02 | $\geq B3$ |
| 15 | 816 | 13.93 | 0.69 | 0.17 | *Be* |

**Table 2.** Color excesses and distance moduli

| *Star* | $E(B-V)$ | $E(U-B)$ | $A(V)$ | $(m-M)_0$ |
|---|---|---|---|---|
| 1 | 1.38 | 1.10 | 4.87 | 11.07 |
| 2 | 1.40 | 1.10 | 4.87 | 11.17 |
| 3 | 1.37 | 1.03 | 4.56 | 11.79 |
| 4 | 1.40 | 1.08 | 4.78 | 11.85 |
| 5 | 1.22 | 0.80 | 3.50 | 11.82 |
| 7 | 1.22 | 0.81 | 3.54 | 12.60 |
| 9 | 1.45 | 1.02 | 4.47 | 12.04 |
| 10 | 1.26 | 0.82 | 3.59 | 13.11 |

V absorption, obtained as average of its determinations through E(B-V) and E(U-B), column 5 the intrinsic distance modulus.

The average value of the individual distance moduli of Table 2 can be taken as representative of the cluster distance, which results to be $\sim$ 2450 pc. This is comparable to the distances reported in PJ (3163 pc in their Table 3, 2754 pc in Figure 53 (b)) whose distance moduli (12.5 and 12.2 mag) are at 1.4$\sigma$ and 0.5$\sigma$ from ours. It is important to stress that the smaller average distance ($< (m-M)_0 >= 11.5$) of the B1 stars with respect to the B3's ($< (m-M)_0 >= 12.4$) may be due to a possible underestimate of their intrinsic V–luminosity. This underestimate is a consequence of our claimed impossibility to resolve in within III–I luminosity class range. Actually, if B1 stars were classified as class II, their average distance modulus would result $\sim$ 12.5, i.e. in good agreement with that relative to B3 stars.

The conversion from spectral types to effective temperatures and bolometric luminosities together with an updated set of evolutionary tracks kindly provided to us by Tornambè (1994), allow us to derive the masses for the stars in our sample. These tracks are the extension to higher masses of those computed by Castellani et al. (1992), which do not include mass loss and overshooting. The mean value of the mass of B1 and B3 stars is 15 and 8 solar masses respectively, corresponding to ages of 12 and 30 million years. This is in agreement with the age estimate of 8 million years given by PJ, who used the evolutionary tracks by Maeder & Meynet (1991).

*Acknowledgements.* We thank Randy Phelps for providing us with PJ photometric data, and the Direction of the Asiago Observatory for the allocated observing time.

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