A photometric study of NGC 458

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We present a CCD investigation of the poorly known SMC young Globular Cluster NGC 458. The NTT data, presented here, allowed us to study in detail the more internal regions of the cluster which are less contaminated by the field. On the basis of theoretical isochrones, a preliminary evaluation of the age is also given.

1. Introduction

The observation of stellar clusters is a relevant tool in testing the goodness of stellar evolution theories. In particular when intermediate-mass stars (about 2-9 $M_\odot$) are investigated, one has to observe young clusters. Unfortunately such a clusters in our galaxy, in general, contains too few stars to allow significant tests to stellar theoretical models, so that it is useful to study young populous clusters in near galaxies; in particular in SMC one of the richest cluster is NGC 458, which appears poorly investigated. In fact there is no direct measurement of his metallicity or reddening, and the estimations of the age (see Hodge (1983), Elson & Fall (1985) and Stothers & Chin (1992)) ranges from 50 to 130 Myr. The only previous photometric work on this cluster is due to Arp (1959) who obtained a photographic BV CM diagram either of the cluster core and of the surrounding field. For this reasons, NGC 458 was observed and a new CMD for this cluster was derived. In the following we will present our preliminary results on NGC 458, giving evaluation for metallicity, reddening and age of this cluster.

2. Observations, data reduction and the resulting CM diagram

The CM diagram is based on three B and three V frames obtained with ESO NTT telescope equipped with SUSI (La Silla, Chile) in december 1995. These data was reduced using the ROMAFOT package (Buonanno et al. 1979, 1983) for crowded field photometry and BV instrumental magnitudes for 1056 stars within a radius of 65″ were measured.

The small size of the SUSI field of view, covering only the NGC458 core, was compensated by using a set of observations based on B V frames obtained at the 0.9 CTIO Telescope (Cerro Tololo, Chile), and kindly provided by A. R. Walker. The relationships for calibration were derived by using 9 photoelectric standards by Walker (1987) and Alvarado et al. (1995) located in the field covered by CTIO measurements. Common stars between NTT and CTIO data were then used to calibrate the NTT photometry.

The NTT-based CM diagram of NGC 458 core ($r < 65 ″$), 1056 stars) is presented in Fig. 1. It shows a well defined MS extending over about four magnitude in V, $V = 18.2$ mag is the estimated visual magnitude of the TO and a consistent population of evolved stars (34 stars) can be recognized from $(B-V)_0 \simeq -0.1$ mag to $(B-V)_0 \simeq 1$ mag.

The CTIO-based CM diagrams, reported in Fig. 2, resemble the main features of the NTT ones. However, it can be recognized that, selecting the external region ($r > 120 ″$) of the cluster, a clump of field stars appears at $(B-V)_0 \simeq 1.0$ mag and $V_0 \simeq 19$ mag.

This clump has been already recognized to be populated of helium burning intermediate mass stars belonging to the field (2-3 $M_\odot$, see Castellani et al. (1990), Bencivenni et al. (1991)).
It is interesting to note that the field of SMC and LMC appears to be very similar according to theoretical previsions discussed in Bencivenni et al. (1991).

3. Results

Since for NGC 458 there is no indication in literature about reddening we first estimated this quantity.

To obtain preliminary indication, we compared the CM diagram of NGC 458 with that of the LMC cluster NGC 1866 which has known reddening and distance modulus and presents a quite similar morphology (Brocato et al. (1989)). Concerning NGC 458 we assumed the distance modulus of SMC, i.e. DM = 18.9 mag (Westerlund (1990)). Then, by assuming the quoted values of distance modulus the two Main Sequences fairly overlap if a reddening of E(B-V) = 0.11 is adopted for NGC 458 (Fig. 3 left). This figure also discloses that the evolved stars of the two clusters are located at about the same luminosity, but NGC 458 evolved stars extend to much bluer colors (temperatures).

Recalling that the temperature extension of the He-burning blue loop in intermediate...
mass stars depends on metallicity (Brocato et al. (1993)), a possible explanation is that NGC 458 and NGC 1866 have quite similar ages (about 110 Myr) but different metallicity (i.e. NGC 1866 more metal-rich than NGC 458). This suggestion is supported by Fig. 3 right, where we overplot two isochrones (Cassisi et al. (1994)) of different metallicities (Z=0.02 and Z=0.006) but same ages (110 Myr) on the observational data.

We also checked the consistency of the age evaluation by plotting (Fig. 4 left) the observed LF of NGC 458 to compare the observed bright MS termination end to the theoretical one obtained by the quoted isochrone of t = 110 Myr.

As a conclusion we find that a fairly good isochrone fitting for NGC 458 (Fig. 4 right) is reached with the following values: DM=18.9, \(E(B-V)=0.11\) mag, \(t=110\) Myr and \(Z=0.006\).

Independent evaluation of metallicity and reddening would certainly improve the reliability of the values derived in this work for the first time and which should be regarded as tentative estimates.

**Figure 3.** Comparison between CM diagram of NGC 458 and NGC 1866; Left: observational data only; Right: as in Left, but with superimposed isochrones for 100 Myr but different metallicity

### 4. Conclusions

We presented a CM diagram for NGC 458 mainly based on NTT data; we are able to fairly identify the various stages of stellar evolution present in this cluster; in particular the MS and the blue loop of the evolved stars are clearly defined.

On the basis of our diagram and by comparison with observational data of NGC 1866 in LMC we estimated the reddening \(E(B-V)=0.11\) mag of NGC 458 and we suggest that these two cluster have very similar age (110 Myr) but different metallicity, being NGC 458 less metal-rich.

Moreover, theoretical isochrones provide a fairly good fit assuming the following quantities: \(Z=0.006\), \(E(B-V)=0.11\) mag, \(t=110\) Myr.

As a final remark we have to note that more work is still necessary in order to im-
prove and refine the interpretation of NGC 458; in particular independent evaluation of reddening and metallicity would greatly improve the reliability of the age determination.

5. Acknowledgments

We are in debt with A.R. Walker that kindly provided us the CTIO data.

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