Mem. S.A.It. Suppl. Vol. 3, 94

Memorie della
Supplementi

Old Open Clusters

Angela Bragaglia and Monica Tosi *

INAF – Osservatorio Astronomico Bologna, via Ranzani 1, 40127 Bologna, Italy
e-mail: `angela@bo.astro.it`

Abstract. Open clusters are among the best tracers of the Galactic disk properties and their evolution in space and time. Within our long term programme dedicated to old Open Clusters we analyze photometric and spectroscopic data to determine in a precise and homogeneous way distances, ages, reddenings, and detailed chemical abundances.

Key words. Galactic disk – Open Clusters – CM diagram – Chemical abundances

1. Introduction

The study of open clusters (OC's) may be rewarding, since they are very good tracers of the Galactic disk properties, provide information on how the Milky Way formed, contribute to the understanding of Galactic chemical evolution, and are laboratories for stellar theory (Friel 1995).

Despite all that, and the fact that there are more than 1200 catalogued OC's, they have been relatively poorly studied up to now. Among OC's we are particularly interested in the old ones (about 80 are presently known), since they provide information on the earliest phases of the Galactic disk. Accuracy and homogeneity of treatment are necessary to fully exploit the OC's, and we have decided to build our own sample.

Send offprint requests to: A. Bragaglia

* Based on a collaboration with G. Marconi, L. Di Fabrizio, G. Andreuzzi, E. Carretta, R.G. Gratton, E.V. Held

Correspondence to: INAF - Osserv. Astron. Bologna, via Ranzani 1, 40127 Bologna, Italy

2. Our sample: photometry and spectroscopy

We are collecting CCD multiband photometric data for a large sample of clusters covering the entire relevant position - age - metallicity range, using ESO and Italian telescopes (see Bragaglia & Tosi 2003, Di Fabrizio et al. 2001 and references therein for the 9 OC's already published).

We use the technique of the synthetic colour magnitude diagrams (CMDs): using evolutionary tracks of different authors and metallicities, we build synthetic CMDs with the same number of stars, photometric errors, and incompleteness factors of the observed ones, trying also to estimate the fraction of binary stars. We then compare both CMD shapes and luminosity functions (see Fig. 1), and choose the best combination of age, distance, reddening and (approximate) metallicity for each model set. Since our results are based on various theoretical sets, we have a clear idea of the real uncertainties involved in the parameters derivation.

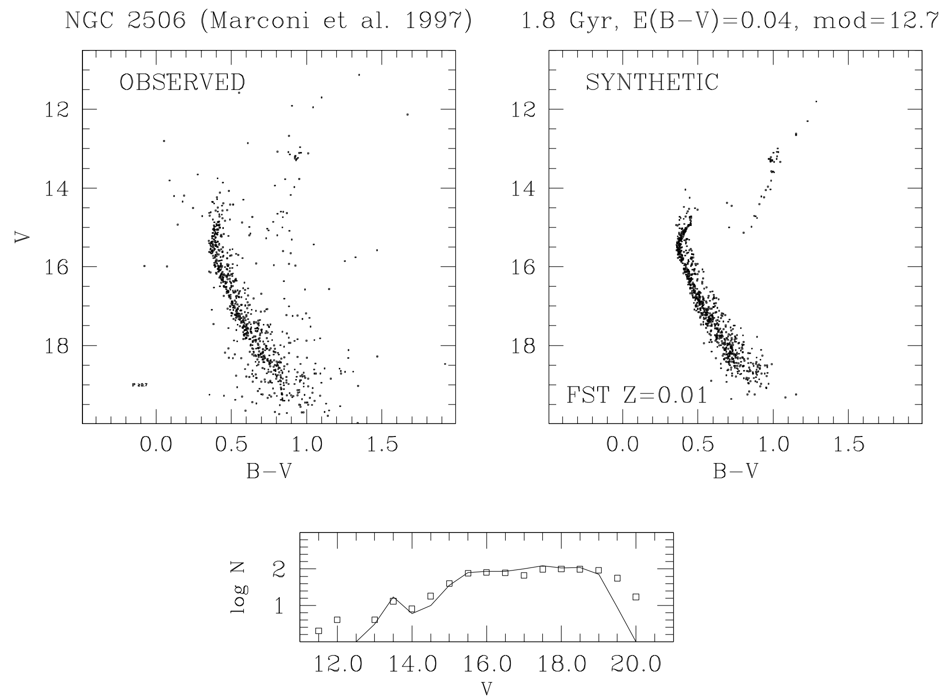

Fig. 1. Left panel: Observed CMD of NGC 2506. Right panel: synthetic CMD based on the FST evolutionary tracks by Ventura et al. (in prep.). Lower panel: observed (open circles) and synthetic (line) luminosity functions.

Having obtained accurate distances and ages we can derive the radial Galactocentric metallicity gradient and its (possible) variation with time (see Fig. 2), important to choose among the existing chemical evolution scenarios, taking into account that a key ingredient is still missing: precise elemental abundances.

The latter are best derived through high resolution spectroscopy, but this has been applied only to a fraction of the OC's (Gratton 2000). We have collected high resolution spectra for stars in 15 old OC's, 11 of which have no previous metallicity determination. First results have already been published (Carretta et al. 2000, Bragaglia et al. 2001a,b), and we are presently working to improve our technique by extensive use of spectral synthesis. An important feature of our analysis is that not only abundances for OC's will be on a homogeneous scale, but they will be on the same scale of Globular Clusters and field stars.

The new multifiber instrument FLAMES@VLT will play an important role for cluster star spectroscopy, since it will acquire high resolution spectra of more than 100 stars in one single shot. Some of the GTO time received by the Ital-FLAMES Consortium will be dedicated to OC's, observing both giant and main sequence stars in the same cluster.

Another important information is often missing for OC's: membership. We have recently begun a program to determine it through radial velocity measurements. Our first target was Be 29, observed with the MOS facility of LRS@TNG, and we have

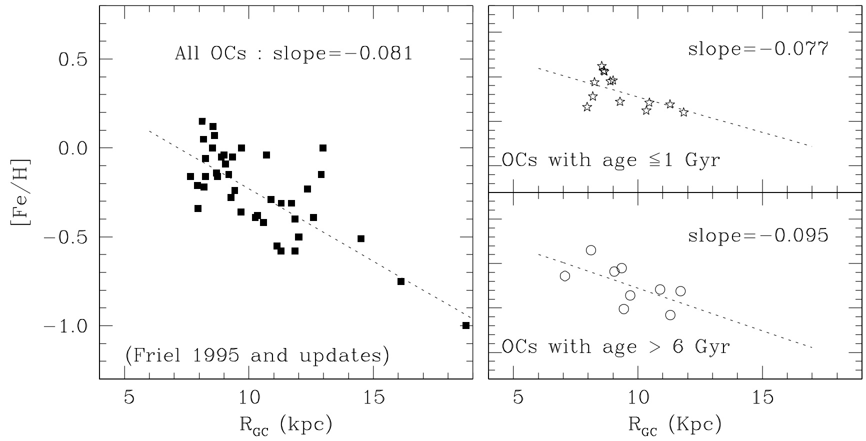

Fig. 2. Galactocentric radial abundance gradient, as derived from OC's. Left panel: if one takes all OC's in Friel (1995, and updates) regardless of their age, the indicated slope is found. Right panels: young and old OC's appear to define slightly different slopes.

been able to separate true cluster members from field interlopers. This information is fundamental both for choosing candidates for follow-up high resolution spectroscopy and for improving our photometric analysis, that can be done on CMDs made only of sure cluster members.

3. Summary

From the photometric sample: i) we derive accurate and homogeneous distances, ages, reddenings and (approximate) metallicities; ii) we study the radial abundance gradient (also by means of our new spectroscopic analysis), both at present time and in the past; iii) we test stellar evolutionary models.

From the spectroscopic sample: i) we derive accurate abundances for Fe, α-elements and other key elements; ii) we put OC abundances on a homogeneous scale, the same of Globular Clusters and field stars; iii) we derive membership for cluster stars.

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