Stellar Populations as Building Blocks of Galaxies
Proceedings IAU Symposium No. 241, 2006
A. Vazdekis & R. F. Peletier, eds.

doi:10.1017/S1743921307008733

Resolving Stellar Populations in Extragalactic Globular Cluster Systems

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Abstract. Photometric studies on globular cluster systems in early-type galaxies are widely used to resolve stellar populations in these galaxies. The knowledge of the age and metalicity structure within the globular cluster systems allows to set constraints on the major star formation episodes in the galaxy. Here we present our method of detecting age sub-populations in globular cluster systems based on optical/near-infrared observations and Monte-Carlo simulations. It is based on the determination of the cumulative age distribution and its comparison to simulated globular cluster systems. On various galaxies we will demonstrate the ability of our method to detect age sub-populations and show how we use the derived age structure to find correlations between various galaxy parameters and the formation/evolution of a given galaxy.

Keywords. galaxies: star clusters, evolution, formation, photometry

1. Introduction

Knowledge about the age structure in galaxies is crucial if we are to understand their formation and evolution and globular clusters are now well established as excellent probes for major star formation events. The work presented on this meeting is based on combined optical and near-infrared photometry of globular cluster systems and aims at the detection of stellar populations in early-type galaxies. We use the results of our semi-numerical approach (e.g. Hempel & Kissler-Patig 2004) to derive the relative age and size of globular cluster sub-populations. Finally we investigate correlations between the age structure and various galaxy parameters, e.g. environment, mass, and spectral index.

2. Method

Our method of detection globular cluster populations of different ages relies on the higher age sensitivity of optical colors in comparison to the more metallicity dependent near-infrared color index. By combining both colors we are able to lift the *in*famous age-metallicity degeneracy (Worthey 1994) of broad band colors to a degree which allows us to distinguish GC populations with an age difference of several Gyr. We use these color-color diagrams (see Figure 1) to derive the cumulative age distribution and compare it to the one derived for simulated systems. For the later we assume an age structure with a given age and relative size of two distinct globular cluster populations (e.g. Hempel & Kissler-Patig 2004). The age distribution of observed and simulated systems will than be compared via a χ^2-test. The age and size combination of the best fitting model is used to quantify the age structure of the globular cluster systems, described by the artificial 'Methuselah' parameter Mth calculated by Mth=frac_{pop1}*age_{age1}+frac_{pop2}*age_{age2} (Hempel *et al.* 2007). An exclussively old stellar population has therefore an *Mth* of 13, whereas the *Mth* for GCSs with a significant intermediate age population will be smaller.

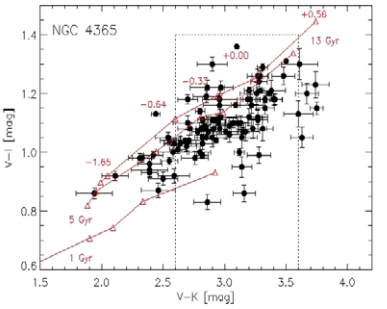

Figure 1. Color-color diagram for NGC 4365, an early-type galaxy in group environment. Only objects with photometric errors $\leqslant$0.15 mag are plotted. The isochrones (solid lines) follow the Bruzual & Charlot SSP model (2003) and refer to an 1,5, and 13 Gyr old stellar population. The metallicity increases with $(V-K)$ and is marked by triangles. The dashed box makes the color selection as described in Hempel & Kissler-Patig (2004).

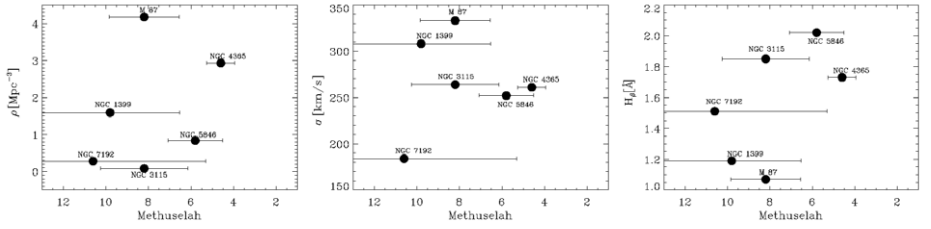

Figure 2. The *Methuselah* parameter as a function of immediate galaxy environment (left), velocity dispersion (middle), and H_β-index (right).

3. Results

Based on the optical and near-infrared data, obtained with the HST/WFPC2 (optical) and VLT/ISAAC (near-infrared) instrument, we derive the cumulative age distribution for a set of 5 galaxies. The galaxies in our sample vary in their respective environment, mass, spectral index. Two of the galaxies, NGC 4365 and NGC 5846 are found to host a significantly large population of GCs younger than 8 Gyr. Using the results of the χ^2-test (\$2) we derive a *Methuselah* value of 4.6 and 5.8 for NGC 4365 and NGC 5846, respectively. In Figure 2 we show how the age structure, represented by the *Mth* parameter correlates with various galaxy parameters. The two galaxies in group environment, NGC 4365 and NGC 5846, are easy to identify by their low *Mth* value, but there are no strong correlations with the galaxy mass or spectral index. However, at this point of our study we interprete this mostly as an effect of the small number of galaxies included. To establish correlations which can be quantified by statistical tests will require a larger galaxy sample.

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https://doi.org/10.1017/S1743921307008733 Published online by Cambridge University Press