Stellar Populations as Building Blocks of Galaxies
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Surface-brightness fluctuations in stellar populations

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Abstract. A new theoretical calibration of surface-brightness fluctuations (SBF) for single age, single metallicity stellar populations is presented for the optical and near-IR broad-band filters, as well as for the HST WFPC2 filters. The IAC-star code is used together with two Padua and the Teramo stellar evolution libraries. A set of single-burst stellar populations with a wide range of ages (3Gy-15Gy) and metallicities (Z=0.0001-0.03) have been computed. The present theoretical calibration shows that the analysis of near-IR SBF provides a very powerful tool in the study and characterization of unresolved stellar populations.

Keywords. galaxies: elliptical and lenticular, galaxies: fundamental parameters, galaxies: stellar content

1. Introduction

The concept of surface-brightness fluctuations (SBF) was introduced by Tonry & Schneider (1988). They developed SBF for its use as an extragalactic distance indicator for early-type galaxies. The ratio of the second moment to the first moment of the stellar luminosity function of the galaxy is used as a standard candle:

$$\bar{L} \equiv \frac{\sum n_i L_i^2}{\sum n_i L_i} \tag{1.1}$$

where n_i is the number of stars of type i and luminosity L_i. The quantity $\bar{L}$ has units of luminosity. The absolute and apparent magnitudes of $\bar{L}$ are $\bar{M}$ and $\bar{m}$, respectively. As SBF are an intrinsic property of a stellar population, they can be used to study some characteristics of the stellar populations of a galaxy, such as age and metallicity as well.

2. Stellar population synthesis

The idea behind this calibration is to develop a tool for unresolved stellar population research. This tool is being implemented through a number of calibration grids, or "Fluctuation Color-Magnitude Diagrams" (FCMD). These are diagrams of integrated colors and SBF magnitudes for a set of theoretical single-burst stellar populations (SSP). Each SSP is represented by a point in the diagram and the plot is completed by a grid of lines connecting same age and same metallicity SSP. Plotting real SBF results from observations onto them will provide estimations of age and metallicity for the observed stellar population.

In order to build the calibration grids, two Padua stellar evolution libraries, Bertelli*et al.* (1994) (hereafter B94) and Girardi *et al.* (2000) (hereafter G00), and the Teramo stellar evolution library by Pietrinferni *et al.* (2004) (hereafter P04) are considered, together with the two bolometric correction libraries by Castelli & Kurucz (2003) (for the optical

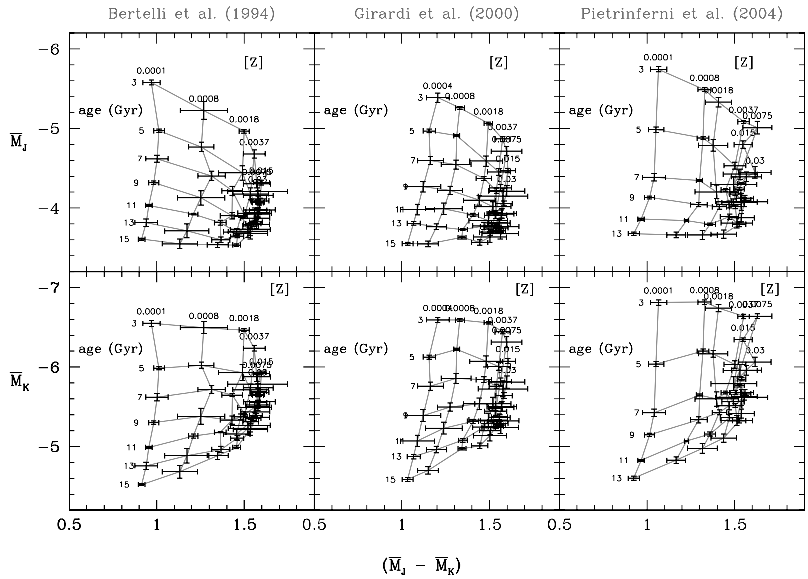

Figure 1. FCMDs obtained using respectively the stellar evolution libraries by B94, G00 and P04. $\bar{M}_J$ and $\bar{M}_K$ have been chosen for this plot, as an example.

and near-IR wavelengths) and Origlia, & Leitherer (2000) (for the HST WFPC2 filters). The IAC-Star code (Aparicio & Gallart 2004) was used.

An example of FCMD in the near-IR is shown in figure 1. It shows the FCMD obtained using respectively the stellar evolution libraries by B94, G00 and P04.

Each SSP is the result of averaging five models with 10^7 stars each. It can be seen that the three stellar evolution libraries provide comparable results. It can also be seen that the age-metallicity degeneracy is broken for low metallicity (Z$\leqslant$0.0018) stellar populations.

3. Conclusions

SBF analyses of unresolved stellar populations have been proved to be a very powerful technique to study and characterize the stellar content of early-type galaxies. Our model results show that SBF studies are particularly powerful for low metallicity stellar populations. In the low metallicity region, the age-metallicity degeneracy is broken, allowing an unambiguous characterization of the stellar population.

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