Stellar Populations as Building Blocks of Galaxies
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Tracing stellar populations of galaxies with the SBF method

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Abstract. Surface Brightness Fluctuations (SBF) are an useful distance indicator of gas-free galaxies as far as 100-150 Mpc with an accuracy of 5-10%. Recent applications have proved that the SBF technique is also a powerful tool to analyze the stellar content of elliptical-like galaxies by means of data/models comparison. Here we present a comprehensive study of the method on the base of a careful analysis of SBF models and a set of accurate multibands SBF measures obtained with HST.

Keywords. (galaxies:) Magellanic Clouds, galaxies: evolution, galaxies: stellar content

1. Models and data

The link between SBF and stellar populations is easily understood considering that the SBF is defined as the spatial fluctuation of the galaxy surface brightness, normalized to the surface brightness itself (Tonry & Schneider (1988)). In order to estimate ages and chemical compositions of stellar systems with the SBF technique, theoretical values for the absolute SBF magnitudes must be available. Then these predictions need to be calibrated on nearby stellar populations, e.g. star clusters. Here, we present a project aimed to investigate the SBF method on both observational and theoretical sides.

The SBF models we developed are based on the general-purpose stellar population synthesis code SPoT (Stellar Population Tools; Raimondo, Brocato, Cantiello, *et al.* (2005)) †. The models are widely applied to interpret recent observations of color-magnitude diagrams, stellar counts, and integrated magnitudes of star clusters and galaxies. The code is specifically optimized to predict the SBF signal of stellar populations spanning a wide range of age and chemical composition (age/metallicity effects). Special care is devoted to analyze the contribution of bright stars, such as thermally pulsating asymptotic giant branch and horizontal branch stars, for instance as a function of mass-loss rate experienced by low and intermediate-mass stars (mass-loss effects). Finally, the SPoT code grounds on a solid statistics procedure for computing integrated quantities of stellar systems. So that, we succeed in predicting the uncertainty of SBF magnitudes and colors taking properly into account statistical arguments (star-richness effect). All these effects have to be carefully considered when the SBF method is used to deconvolve the evolutionary status of the underlying stellar-population mixture in a galaxy.

† All the models are available at the URL: http://www.oa-teramo.inaf.it/SPoT

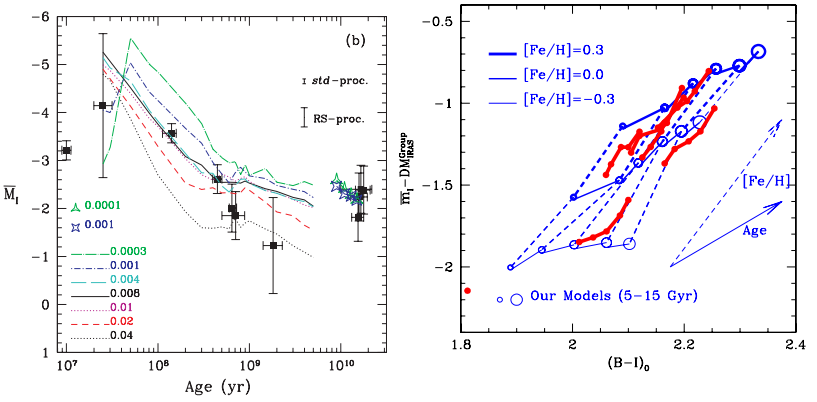

Figure 1. Data/models comparison. WFPC2/HST I-band measures of 11 star clusters of LMC (left panel, squares), and ACS/HST I-band measures of 7 early-type galaxies (right panel, red bold lines) are compared with models of different chemical compositions and ages.

To calibrate SBF on resolved simple stellar populations (SSP) of the Local Group, we consider 11 star clusters of the Large Magellanic Cloud (LMC), spanning the age interval from few Myr to several Gyr (Raimondo, Brocato, Cantiello, *et al.* (2005)). We measured for the first time the V and I-band SBF of star clusters by using the stellar photometry derived from high-resolution WFPC2/HST images. Clusters younger than 5 Gyr show SBF in agreement with predictions of relatively metal-rich SSP (Z= $0.004 - 0.01$), while older clusters are fitted by models aged 12-15 Gyr of lower metallicities, similarly to Galactic globular clusters (Cantiello, Raimondo, Brocato, *et al.* (2003)).

Taking advantage of the high capabilities of ACS/HST, and the refinement of the data-analysis procedure, in Cantiello, Blakeslee, Raimondo, *et al.* (2005) we succeeded in revealing the existence of an SBF radial-gradient ($\bar{M}_I$) in all the galaxies in the analyzed sample (7 early-type galaxies). The work is extended to consider $F435W$-band ($\sim B$-band) images in Cantiello, Raimondo, Blakeslee, *et al.* (2007). The I-band SBF gradient (5 concentric annuli are considered) appears related to the integrated $(B-I)_0$ color radial-profile: the I-SBF gets fainter for increasing radius, while the $(B-I)_0$ integrated color gets bluer. The comparison with our SBF models shows that the succession of annular measurements follows preferentially lines of increasing $[Fe/H]$ towards the center of the galaxy, with minor changes in age. The only exception is NGC1344 (brightest SBF sequence in the figure) for which models indicate the presence of a young stellar population outward from the center. Interestingly, this galaxy presents shell features. These results support the fundamental role that the SBF method may play for understanding unresolved stellar populations of distant galaxies.

Acknowledgements

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