MUFFIT: a MUlti-Filter FITting code to explore the stellar content of galaxies in photometric surveys.

L.A. Díaz-García[1], A.J. Cenarro[1], C. López-Sanjuan[1], and the ALHAMBRA Team

[1]*Centro de Estudios de Física del Cosmos de Aragón (CEFCA), Plaza San Juan, 1, Planta-2, E-44001, Teruel, Spain*

1. Introduction

Nowadays, there is an increasing number of multi-filter surveys, e.g. ALHAMBRA (Moles et al. 2008), COSMOS (Ilbert et al. 2009), SHARDS (Perez-Gonzalez et al. 2013), J-PAS (Benitez et al. 2014), J-PLUS (Cenarro et al. 2014 in prep.); with a vast volume of high-quality data. This kind of surveys sample the spectral energy distribution (SED) of galaxies, and owing to their configurations, the retrieved SEDs are half-way between classical photometry and spectroscopy, being in practise a low-resolution spectrum. The code MUFFIT (Díaz-García et al. 2014, in prep.) is generically designed to determine the main stellar population parameters of galaxies using their multi-filter SEDs.

2. The data

The stellar population code MUFFIT is generically designed for all types of multi-filter surveys (see Fig. 1). However, we make use of the data in the ALHAMBRA Gold catalogue (Molino et al. 2014) to prove the reliability of our techniques owing to the suitable characteristics of this survey.

The ALHAMBRA survey is composed by 20 contiguous, medium-band (FWHM ~300Å) in the optical range 3500-9700Å, that are supplemented with the standard NIR filters *J*, *H*, and *Ks*.

J-PLUS | ALHAMBRA | J-PAS

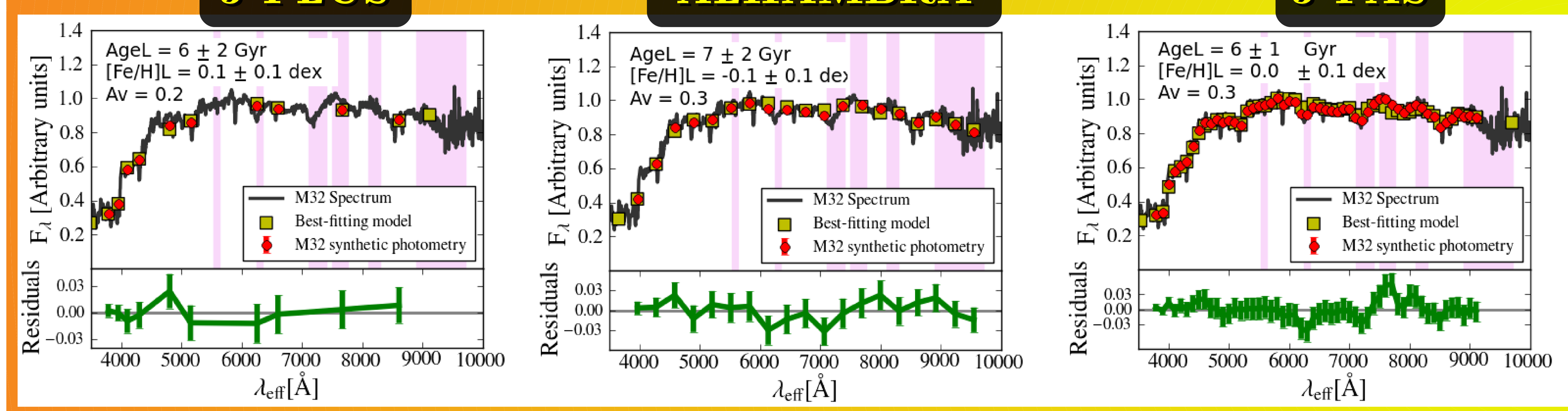

Fig. 1. The complete spectrum of M32, in black, the M32 spectrum at the J-PLUS, ALHAMBRA, and J-PAS resolution, in red, and the best fitting derived from our code with a mixture of two MIUSCAT SSPs (Vazdekis et al. 2012) using a Kroupa's IMF, in yellow. Pink areas illustrate spectral ranges particularly affected by telluric absorptions and strong sky emission lines.

3. Overview of the analysis techniques

After building photometric predictions of colours, using a ground set of single stellar population models that ranges different stellar population parameters (mainly age and metallicity; although for a general case IMF or α-abundances as well) for a given extinction law, we compare the fluxes of any galaxy with the predictions of a mixture of two single stellar populations, to automatically provide the stellar population parameters (in this work: age, metallicity, extinction, redshift, and stellar mass) making use of a χ^2-test weighted by errors. During the analysis stage, our code smartly removes those bands that may be affected by emission lines, restricting the plausible redshift space, as the redshift of the galaxy can be treated as another free parameter. In addition, photo-*z* predictions from external codes can be included to restrict the galaxy redshift (*BPZ2.0* in ALHAMBRA, Molino et al. 2014). Our results are not limited to provide the parameters of the best solution, but we also account for the compatible space of parameters by a Monte Carlo method using the proper photometric uncertainties in each band. For further details see Díaz-García et al. (2014, in prep.)

diaz@cefca.es

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4. Testing the performance of MUFFIT

We emulate the analysis of the M32 stellar content convolving its spectrum with the J-PLUS, ALHAMBRA, and J-PAS photometric systems (see Fig. 1). After running MUFFIT, we obtain that M32 is composed by a mixture of two main populations, one of 2 Gyr and the other one 11 Gyr, with a luminosity-weighted age as indicated in the boxes in Fig. 1. This is in nice agreement with previous works in the literature (Coelho et al. 2009).

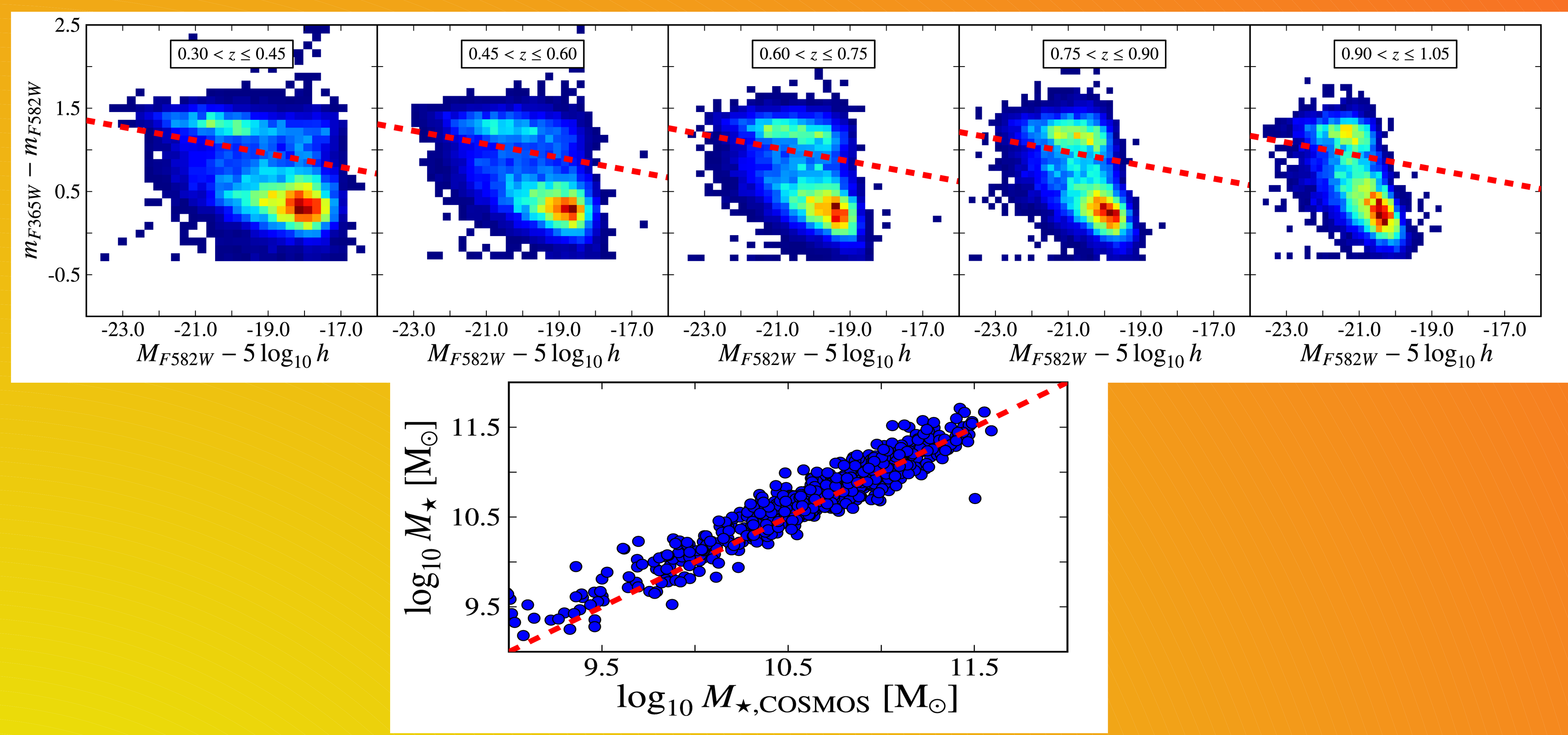

Fig. 2. Top panel, CMD built with MUFFIT in ALHAMBRA. On the bottom panel, comparison between stellar masses for a common sample of RS galaxies in ALHAMBRA (computed with MUFFIT) and COSMOS.

We build the ALHAMBRA colour-magnitude diagram (CMD, top panel in Fig. 2) through the k-corrections provided by MUFFIT, and we get the colour bimodality of galaxies: red-sequence (RS) and blue cloud; in full agreement by previous studies (Bell et al. 2004; Fritz et al. 2014).

For a sample of RS galaxies in common between ALHAMBRA and COSMOS, we compare the retrieved stellar masses with MUFFIT and those in COSMOS, obtaining a very good agreement between the two samples (bottom panel in Fig. 2).

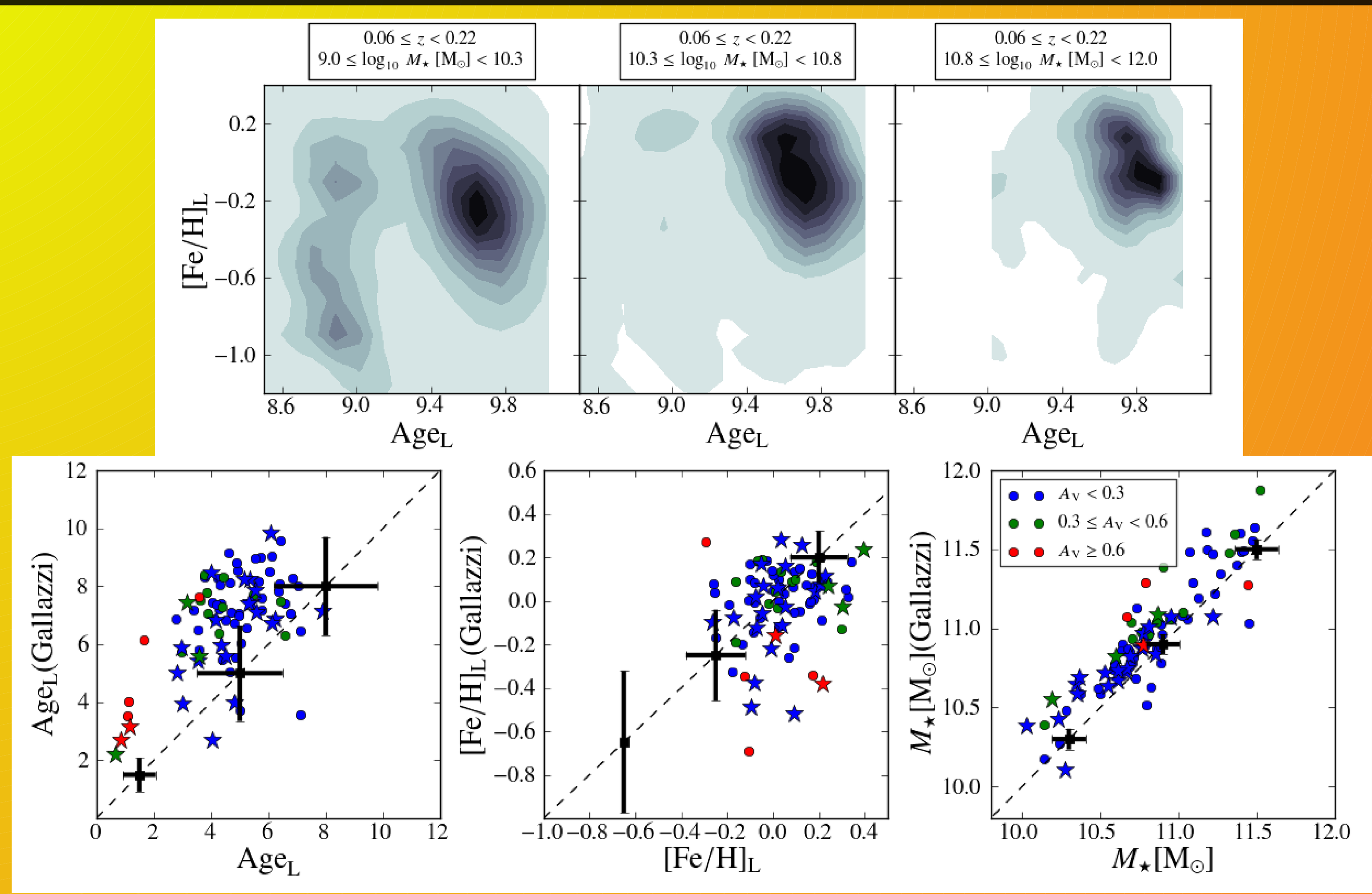

Fig. 3. Top panel, distribution of ages and metallicities for a sample of ellipticals at different stellar mass bins. On the bottom panel, comparison between ages, metallicities and stellar masses for a common sample of RS galaxies in ALHAMBRA and SDSS. Typical error bars in the parameters are plotted on top of the one-to-one relationship (dashed-line). The extinction values recovered with MUFFIT are represented by colours (see inner panels).

Using MUFFIT, we have studied the stellar populations of a sub-sample of ellipticals (Es) in ALHAMBRA, comparing our results with the ones presented in Gallazzi et al. (2005, hereafter G05) for a similar sample of Es from SDSS. As expected, we obtain that massive galaxies are, on average, more metal rich and older than their low-mass counterparts (see top panel in Fig. 3). Overall, it is remarkable the agreement between the age-metallicity maps derived with MUFFIT and the ones given in G05, despite the later using spectroscopy and index measurements. The bimodal distribution in age-metallicity for the least massive case is also present.

In addition, making use of the catalogues of G05, we present a comparison of the stellar populations recovered by MUFFIT+ALHAMBRA and the spectroscopic results from G05 (bottom panel in Fig. 3) for the same galaxy sample in common between ALHAMBRA and SDSS. Despite the small offset in age due to intrinsic differences in the analysis techniques (line-strengths vs SED fitting), both results are in very good agreement.

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