Stellar Populations as Building Blocks of Galaxies
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A new approach to derive [α/Fe] for integrated stellar populations

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Abstract. Choosing either an empirical or a theoretical stellar library in stellar population models is a subject of debate. Theoretical models do not perfectly match high-resolution spectra of real stars, but we can use them to overcome the natural limitations of empirical libraries on covering abundance patterns that differ from solar neighbourhood stars. Here, we will mix stellar population synthesis models based on both theoretical and empirical libraries, in order to explore a new method to constrain the enhanced α-elements pattern on galaxies.

1. Introduction

Unveiling the relative abundances of individual elements of integrated stellar populations in galaxies provides strong constraints on the metal enrichment and on the epochs of star formation of these systems. While Single Stellar Population synthesis models based on empirical libraries (Worthey *et al.*, 1992; Bruzual & Charlot, 1993; Vazdekis *et al.*, 2007 (V07)) only can qualitatively constrain the overabundant pattern relative to solar scales (Carretero *et al.*, 2004), models to constrain α-enhacement so far are limited to the synthesis of Lick/IDS indices (e.g. Thomas *et al.*, 2003; Proctor *et al.*, 2004; Tantalo *et al.*, 2004). A new method is still needed, since the available ones are limited to low resolution studies (FWHM $\approx$ 8.4 Å, Lick/IDS system), whereas higher resolution spectra should allow to better explore galaxy spectra.

2. Approach

With the theoretical libraries (e.g. Lejeune *et al.*, 1997; Westera *et al.*, 2002; Coelho *et al.*, 2005 (CO05); Munari *et al.*, 2005), one can explore virtually any element abundance pattern and the spectra can be calculated at very high resolution along a wide wavelength coverage. On the other side, as stars from empirical libraries (e.g. STELIB, INDO-US, MILES) mainly represent the solar neighbourhood, the SSP models built based on them are biased to the solar chemical pattern. Here, we propose to derive the α-enhancement of galaxies combining the use of SSP of V07 built with MILES (Sánchez-Blázquez *et al.*, 2006), with a new set of SSP models built with the theoretical library of CO05.

We use V07 models to calibrate the indices measured on our solar scaled SSP models at any resolution ($\Delta Ic = I_{MILES} - I_{CO05}$). The indices derived on our non solar scaled abundances models are corrected to reproduce indices measured on V07 models. $I\alpha = I\alpha_{CO07} + \Delta Ic$. This allows us to inspect the ratio between two indices as a function of [α/Fe]. For example, while magnesium is the main α-element in the visible wavelength range spectra of galaxies, and the main component of the Mgb index, iron is the basic ingredient of Fe3 index (Korn *et al.*, 2005). With our approach, we can inspect how the ratio of both indices (Mgb/Fe3) is related to [α/Fe] and so far we can built the curve $\mathcal{R}$(Mgb/Fe3) =$\mathcal{R}$(age,[M/H],[α/Fe]) (See Figure 1.*Right*). Once the total metallicity

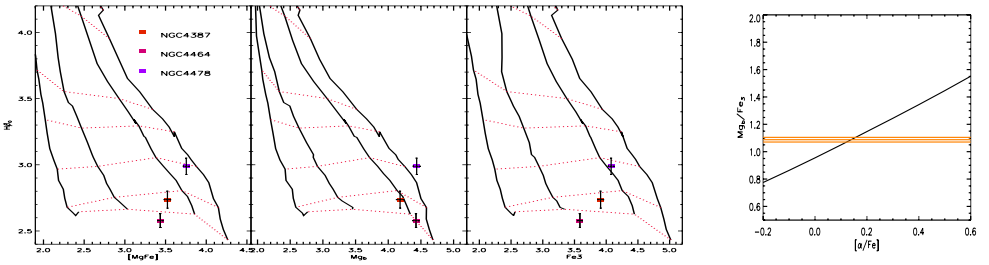

Figure 1. *Left*: [MgFe], Mgb and Fe3 vs. H_{β_o}. Model grids of V07 with various ages and metallicities are overplotted; metallicity increases from left to right with bold lines of [M/H] =-0.7,-0.4,+0.0 and +0.20; age increases from up to bottom with dotted red lines of age = 3.0, 5.6, 8.0,11.2 and 17.8 Gyr. Model SEDs are smoothed to match the resolution of galaxies, here σ = 135 km/s. *Right*: $\mathcal{R}$(Mgb/Fe3) for a SSP of 8 Gyr and [Fe/H]=0.14 at σ = 135 km/s. (NGC4478 main parameters from Table 1). Direct measurement of Mgb/Fe3 for NGC4478 (horizontal line) is used to infer the [α/Fe] value.

[M/H] and the age of a galaxy are constrained, the ratio Mgb/Fe3 is used to derive $[\alpha/Fe]$ via $\mathcal{R}$(Mgb/Fe3) (Figure 1 and Table 1).

3. Discussion

The results presented here for the Virgo galaxies are preliminary, based on a simplified set of SSPs models, for a single age and a single metal content. Nevertheless, we wanted to illustrate our method as an example of the powerfull potencial of using combined SED SSP models, in order to take into account for α-enhancement in moderate resolution analysis. More computations covering a wider range of parameters are currently under way. A new set of SED SSP models mixing CO05 and MILES library, at 2.4 Å resolution for different α-enhancement ratios will be soon available.

Table 1. METHOD APPLIED ON 3 ELLIPTICAL GALAXIES IN VIRGO CLUSTER

Galaxy	σ(km/s)	Age(Gyr)	[M/H]	[α/Fe]	[Fe/H] = [M/H] - A [α/Fe]
NGC4387	135	14.5±1.9	−0.11±0.05	0.07±0.02	−0.15±0.05
NGC4464	135	>17.8	−0.19±0.05	0.23±0.02	−0.35±0.05
NGC4478	135	8.2±1.3	0.14±0.06	0.14±0.02	0.04±0.06

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