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CONSTRAINING THE DETERMINATION OF THE STAR FORMATION HISTORY OF GALAXIES

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RESUMEN

Exploramos la habilidad de derivar la Historia de Formación Estelar a partir de espectros de galaxias individuales con dos diferentes algoritmos: GASPEX y DinBas 2D. El primero es un método no paramétrico que determina la fracción de masa de la galaxia formada en un conjunto selecto de edades. El segundo es un nuevo enfoque que encuentra la mejor combinación de edad y fracción de masa formada por dos poblaciones estelares simples que sumadas ajustan al espectro problema. Para poder restringir las ventajas y las limitaciones de este novedoso método, presentamos simulaciones con espectros teóricos para diferentes historias de formación estelar y edades a fin de abarcar todos los tipos de galaxias en la secuencia de Hubble.

ABSTRACT

We explore the ability of two different algorithms, GASPEX and DinBas2D, to derive the Star Formation History from a galaxy spectrum. The former is a non-parametric method which derives the galaxy mass fraction formed in a pre-selected set of epochs. The second is a new approach that finds the best combination of age and mass fraction of two simple stellar populations that fits the target spectrum. In order to constrain the advantages and limitations of this novel method, we apply it to simulated galaxy spectra that cover the Hubble sequence.

Key Words: galaxies: evolution — stars: formation

1. INTRODUCTION

The determination of the History of Star Formation Rate (SFRH) in galaxies allow us to determine parameters that are useful to study the evolution of the Universe. At present, there exists several methods to derive details of the time evolution of the SFR in galaxies: Heavens et al. (2000), Mateu et al. (2001), Cid Fernandes et al. (2005), Mathis et al. (2006), Panter et al. (2007). These methods use different ways to find the coefficients of a linear combination of Simple Stellar Population (SSP) spectra (basis) that best fits the target spectrum. The ages of the basis SSPs are fixed by the user of the algorithm in such a way that the ages at which important changes on stellar spectral morphology occurs are included. The solutions are degenerate in the sense that for a composite stellar population spectrum, there exists more than one solution (SFRH). Mateu (2007, in this volume) has introduced DinBas2D, a novel method in which a linear combination of only two SSPs is used to fit the target spectrum. He argues that typical spectra in the SDSS database are well fitted with the two component model, and that only in the case of higher quality spectra, and/or a wider wavelength range coverage, it is justified to increase the number of SSP components. We present the first of a series of experiments that test the capabilities of this dynamical basis method versus the standard approach that uses a fixed-age SSP basis. We have performed a set of theoretical simulations and compare the DinBas2D solution with those obtained with GASPEX (Mateu 2001).

2. RESULTS

We calculate a set of Bruzual & Charlot (2003) models corresponding to solar metallicity and an exponential declining star formation rate: SFR $= 1/\tau\ \exp(-t/\tau)$, with $\tau = 1, 3, 5, 7$ and 9 Gyr, and ages 4, 6, 8, 10 and 13.5 Gyr, in order to cover a wide range of galaxy types and evolutionary stages. We add noise to each spectrum assuming a signal-to-noise-ratio S/N = 20, at all wavelengths. This set of models is used as target spectra for GASPEX and DinBas2d, limiting the wavelength range between 3600 and 7500 Å, to simulate the SDSS spectra.

In Figures 1, 2 and 3, we compare the values of $B-V$, B(4000) (the 4000 Å break), and Hδ, recovered with GASPEX and DinBas2D. We can see that the observables that correspond to wide features, like $B-V$ and the 4000 Å break, are recovered identically by the two algorithms. The value of the Hδ equivalent width shows more dispersion between the two

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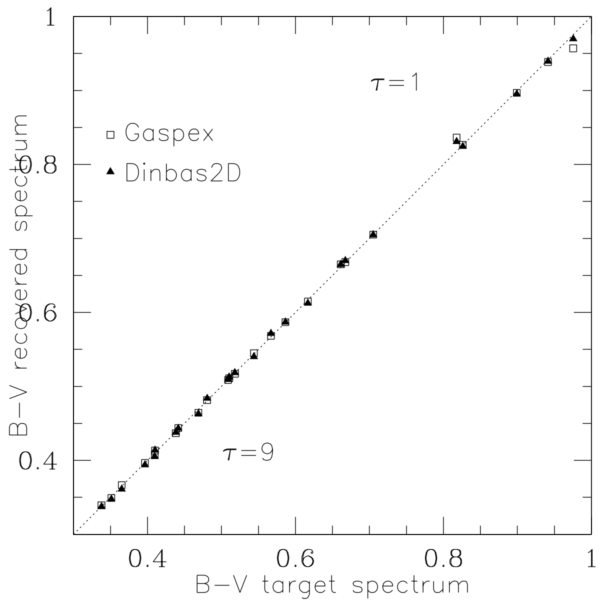

Fig. 1. Comparison between the B-V of target spectra and the recovered value using DinBas2D (triangles) and GASPEX (open squares). Early type galaxies are on the upper right corner, and actively star forming galaxies are on the lower left corner.

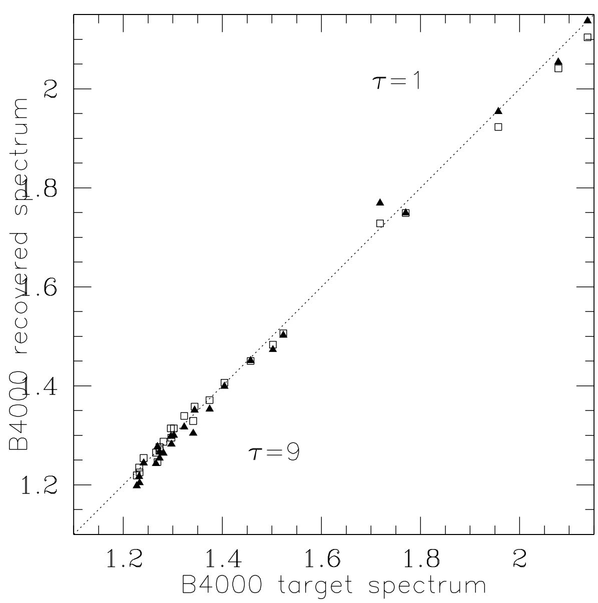

Fig. 2. The same as Figure 1 but for B(4000).

models, with no systematic tendency and in concordance with the noise addition that obviously affects more sensitively the narrow band features.

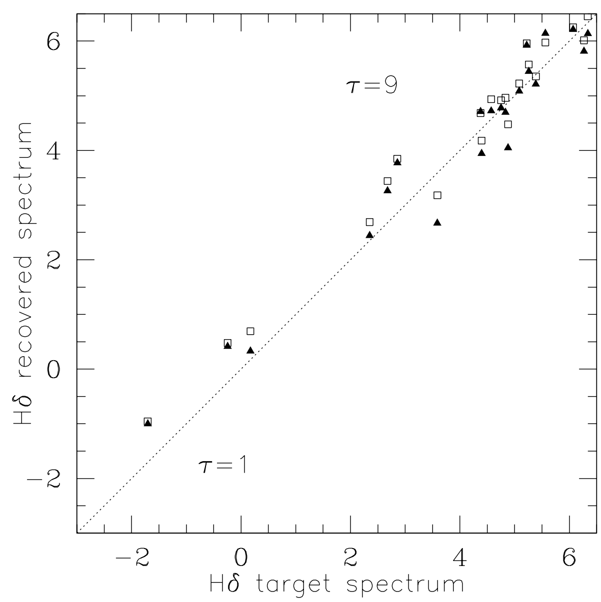

Fig. 3. Comparison between the Hδ of target spectra and the recovered value using DinBas2D (triangles) and GASPEX (open squares). Early type galaxies are on the lower left corner, and actively star forming galaxies are on the upper right corner.

We conclude that in $B-V$, Hδ, and B(4000), the two component model DinBas2d recovers the same SFRH that other standard methods like GASPEX. The next step in the test process will be to compare the physical parameters derived from the SFRH determined by both methods, mainly the total galaxy mass and the mean galaxy age.

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