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Comparing six evolutionary population synthesis models

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Abstract. We compare six evolutionary population synthesis (EPS) models, which have been popularly used in stellar populations analyses for galaxies. The resulted stellar populations of star-forming galaxies and E+A galaxies from these EPS models show that the dominated contribution (fraction) from young, intermediate and old populations to their lights are consistent, although the individual numbers may change significantly, 3-30%, which could relate to the different ingredients in EPS models, such as the stellar library, the stellar evolution tracks etc.

Keywords. galaxies: abundances, galaxies: evolution, galaxies: spiral, galaxies: stellar content

1. Introduction

Stellar population is a fundamental property of galaxies, and can provide important information on the formation and evolution of them. The EPS models provide Simple Stellar Populations (SSPs) with different ages and metallicities which can be used for stellar population analyses of galaxies. Several EPS models have been used popularly. However, their basic ingredients are not exact same, such as the grids of ages and metallicities, initial mass function (IMF), star formation rates (SFR), stellar evolution tracks etc. In this work, we compare six popular EPS models by using their SSPs to fit example spectra of galaxies, and then to compare the resulted stellar populations. The STARLIGHT code (Cid Fernandes *et al.* 2005) is used to fit the spectra.

2. The EPS models, the example spectra and the results

The six EPS models to be compared here are BC03 (Bruzual & Charlot 2003), CB07 (new version of BC03, which includes the new stellar evolution prescription for TP-AGB stars), Vazdekis/Miles (Vazdekis *et al.* 2003), Maraston05 (Maraston 2005), GALEV (Kotulla *et al.* 2009) and GRASIL (Silva *et al.* 1998). Table 1 presents their basic ingredients. There are several choices of IMFs and stellar evolution tracks in the models. We only list the one frequently used, which is what we used in this work.

The example spectra are taken from Chen *et al.* (2009) for star-forming (SF) galaxies and Goto (2007) for E+A galaxies. The spectrum of individual objects have been combined to improve the S/N ratios of the spectra.

Trying to use the consistent SSPs of the EPS models, we adopt 9 SSPs with ages equal or close to 0.1, 0.28, 0.5, 0.9, 1.4, 3, 6, 10, 13 Gyrs and solar metallicity in each of them. We further arrange these 9 SSPs in 3 age bins: young with age $\leqslant 2\times10^8$ yr, old with age $\geqslant 2\times10^9$ yr, and intermediate with ages between them. The light fractions of young, intermediate and old populations for the SF and E + A galaxies resulted from the spectral synthesis are given in Table 2. It shows that the dominant populations are

Table 1. Comparisons among 6 different EPS models.

models	BC03	CB07	Vazdekis/Miles	Maraston 05	GALEV	GRASIL
Stellar library	STELIB/BaSeL3.1	STELIB/?	Miles2006	BaSeL2.0	BaSeL2.0	Kurucz1992
resolution($\AA$)[a]	3	3	2.3	20	20	20
wavelength ($\AA$)	91-1.6x10^6	91-3.6x10^8	3540-7410	91-1.6x10^6	91-1.6x10^6	91-1.2x10^7
N_λ	6900	6917	4300	1221	1221	1264
age(Gyr) (grids)	0-20(221)	0-20(221)	0.1-18(46)	10^{-6}-15(67)	4x10^{-3}-16(4000)	10^{-4}-20(55)
Z (grids)	0.0001-0.05(6)	0.0001-0.05(6)	0.0004-0.03(6)	0.0001-0.07(6)	0.0004-0.05(5)	0.0001-0.1(7)
IMF	Salpeter	Chabrier	Salpeter	Salpeter	Salpeter	Salpeter
track	Pa 94	Pa 94+ Marigo 07	Pa 00	Cassisi/Pa 00 /Geneva	Pa 99	Pa

Notes: [a]: resolution in visual regions. For stellar library, STELIB/BaSeL3.1 refers to Le Borgne *et al.* (2003); Miles2006 refers to MILES in Sánchez-Blázquez *et al.* (2006); BaSeL 2.0 refers to Lejeune *et al.* (1998); Kurucz1992 refers to Kurucz (1992). For stellar evolution track, Pa 94 refers to Fagotto *et al.* (1994); Pa 00 refers to Girardi *et al.* (2000); Cassisi refers to Cassisi *et al.* 2000); Marigo 07 refers to Marigo & Girardi (2007); Pa 99 refers to Bertelli *et al.* (1994); Geneva refers to Schaller *et al.* (1992). For IMF, Salpeter refers to Salpeter (1955); Chabrier refers to Chabrier *et al.* (2003). For SFR, the instantaneous bursts are always adopted here.

Table 2. Stellar populations (the light fractions of different populations) of star-forming and E+A galaxies. Y, I, O refer to the young, intermediate and old populations, respectively.

Galaxies	age-bin	BC03	CB07	Vazdekis/Miles	Ma05	GALEV	GRASIL
Star-forming	Y	34.8	58.6	49.04	51.04	31.94	42.78
	I	52.88	6.39	26.82	39.66	44.97	35.99
	O	12.31	35.01	24.14	9.3	23.1	21.23
E+A	Y	11.3	21.26	16.09	25.9	21.96	22.91
	I	74.57	56.3	62.55	59.62	66.05	59.26
	O	14.13	22.44	21.37	14.48	11.99	17.83

almost consistent, although the individual numbers change significantly, 3-30%, which could relate to the parameters in models, such as stellar library, stellar evolution tracks etc. Also, the SF galaxies have more young stellar populations than the E+A galaxies.

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