The intriguing life of massive galaxies
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The LF of TP-AGB stars in the LMC/SMC

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Abstract. We show that Monte Carlo simulations of the TP-AGB stellar population in the LMC and SMC galaxies using the CB* models produce LF and color distributions that are in closer agreement with observations than those obtained with the BC03 and CB07 models. This is a progress report of work that will be published elsewhere.

Keywords. stars: evolution, stars: AGB and post-AGB, galaxies: stellar content, galaxies: evolution

1. Introduction

It has been known for quite some time now that intermediate mass stars in the thermally pulsing asymptotic giant branch (TP-AGB) phase of their evolution contribute at least 50% of the NIR light in a simple stellar population (SSP) of age 1-2 Gyr, e.g., Maraston (2005), Bruzual (2007, 2011). The treatment of this stellar phase in stellar population synthesis models determines the predicted spectral energy distribution (SED) of stellar populations in this wavelength and age range. In Fig. 1 we compare the predictions of Maraston (2005) for a Salpeter IMF, $Z = Z_{\odot}$, SSP model at two different ages, with the predictions of three different versions of our code: (a) the BC03 models; (b) the minor revision of these models introduced by CB07, and (c) a major revision of this code and models (in preparation, hereafter CB*). The CB07 models use the same sets of stellar tracks and spectral libraries as BC03, except for the TP-AGB stars, for which CB07 follow the semi-empirical evolutionary prescriptions by Marigo & Girardi (2007) and Marigo *et al.* (2008). The CB* models used in this paper are based on the stellar evolution models computed by Bertelli *et al.* (2008). Tracks are available for metallicities Z = 0.0001, 0.0004, 0.001, 0.002, 0.004, 0.008, $Z\odot$=0.017, 0.04, and 0.07. In CB* the evolution of TP-AGB stars follows a recent prescription by Marigo & Girardi (private communication), which has been calibrated using observations of AGB stars in the Magellanic Clouds and nearby galaxies (Girardi *et al.* 2010; Melbourne *et al.* 2012). In the optical range, the CB* models are available for the IndoUS (Valdes *et al.* 2004), Miles (Sánchez-Blázquez *et al.* 2006), Stelib (Le Borgne *et al.* 2003), and BaSeL 3.1(Westera *et al.* 2002) spectral libraries. The NIR spectra of TP-AGB stars in CB* are selected from the compilation by Lançon & Mouhcine (2002), the NASA Infrared Telescope Facility (IRTF) library (Rayner *et al.* 2009), and the C-star model atlas by

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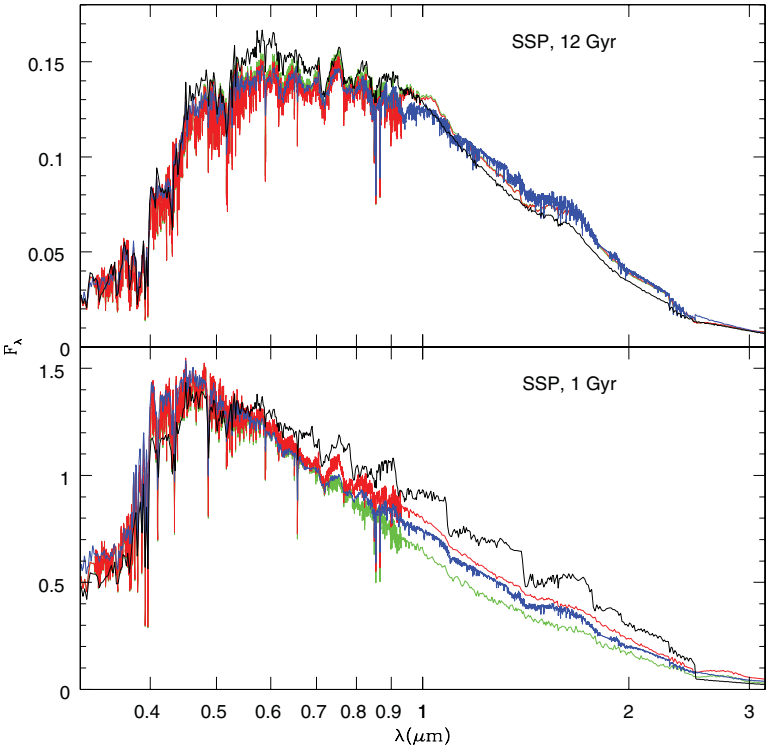

Figure 1. SED in the optical and NIR range for a Salpeter IMF, $Z = Z_{\odot}$, SSP at the age indicated inside each frame. The different lines clearly visible in the 1 Gyr frame in the 1-2μm range represent from bottom to top the models by BC03, CB* (see text), CB07, and M05. Whereas the fractional range in flux spanned by these models may reach 100% at 1 Gyr, it is less than 15% at 12 Gyr. Kriek *et al.* (2010), Melbourne *et al.* (2012), and Zibetti *et al.* (2013) have shown evidence that the treatment of the TP-AGB stars in the CB07 and M05 models overestimates the contribution by TP-AGB stars in the NIR, favoring BC03 and CB*.

Aringer *et al.* (2009). The effects of mass loss and reddening in the spectra of TP-AGB stars have been included in these models as described by González-Lópezlira *et al.* (2010). The treatment of the TP-AGB in the M05 models is based on the Fuel Consumption Theorem and is thus completely independent of the prescriptions used in the BC/CB models.

2. Modeling the LF of TP-AGB stars in the LMC and SMC

We model the distribution of TP-AGB stars in the CMD in various optical and NIR bands for a stellar population of $Z = 0.008$, close to the LMC metallicity, by means of Montecarlo simulations (cf. Bruzual 2002, 2010). At each time step the mass formed in stars is derived from the LMC star formation history (Harris & Zaritsky 2009). The stars are distributed in the CMD according to the isochrones computed with the CB*, CB07, and BC03 models described in §1. Fig. 2 shows a comparison of the LF derived from our three simulations and the observed *SAGE* data set (Srinivasan *et al.* 2009) in the *IRAC* [4.5]μm band. The corresponding *IRAC* [3.6] − [4.5]μm color distributions are shown in Fig. 3. Using the same procedure and the SFH of the SMC from Harris & Zaritsky (2004) we model the TP-AGB stellar population in the SMC galaxy. In

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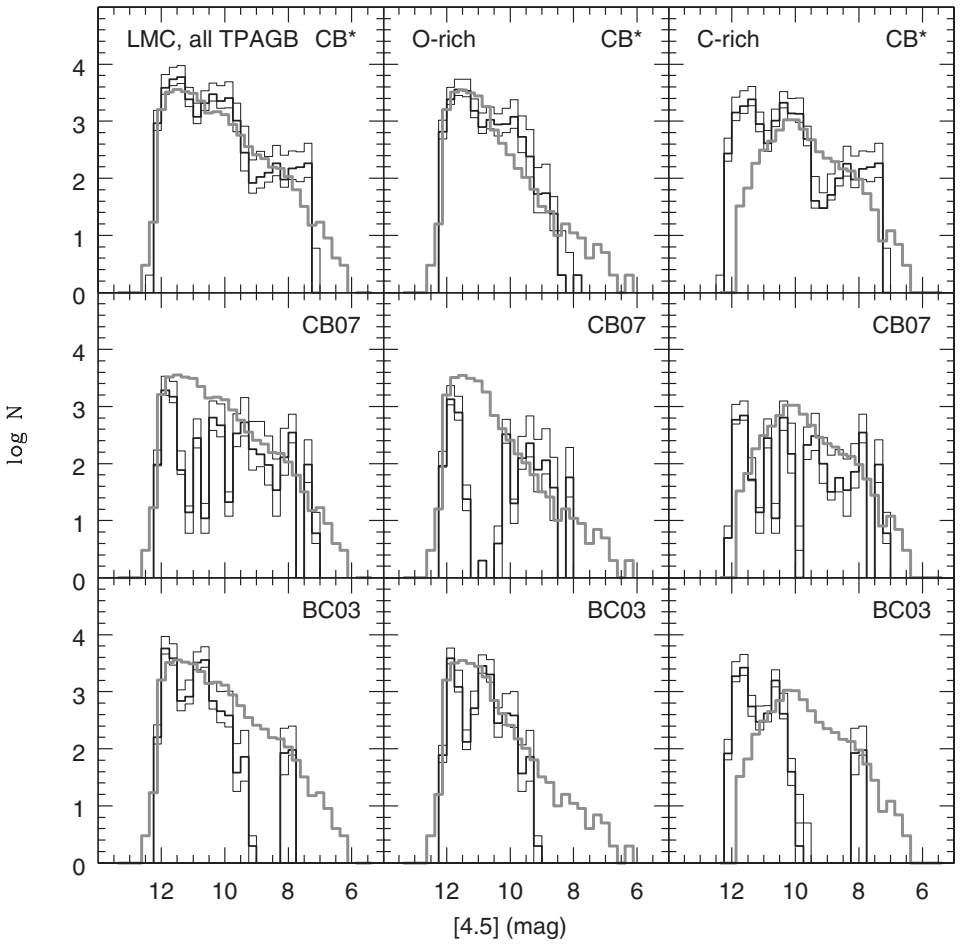

Figure 2. LF derived from our Monte Carlo simulations of the star formation history of the LMC using the CB*, CB07, and BC03 models, and from the observed *SAGE* data set (Srinivasan *et al.* 2009) in the *IRAC* [4.5]μm band. The left column corresponds to all the TP-AGB stars. In the central and right column only the O-rich and C-rich TP-AGB stars are shown, respectively. For the simulations we assumed the Salpeter IMF, $Z = 0.008$ isochrones, and we kept all the stars with apparent $K \leqslant 12$ mag. The *heavy gray-line* corresponds to the *SAGE* LF. The *heavy black-line* corresponds to the simulation LF using the central value of the LMC SFH (Harris & Zaritsky 2009). The bracketing *light black-lines* correspond to the upper and lower limit of the SFH derived from the error bars given by these authors.

the case of the SMC the chemical evolution indicated by Harris & Zaritsky (2004) is included in our simulations. Inspection of Figs. 2-4 shows that the LFs computed with the CB* models are in closer agreement with the observations that those computed with the BC03 and CB07 models. These results are consistent with the findings by Kriek *et al.* (2010), Melbourne *et al.* (2012), and Zibetti *et al.* (2013) (see caption to Fig. 1), and support our choice for the treatment of TP-AGB stars in the CB* models. We do not have at hand enough information (isochrones) to perform the same kind of comparison with the M05 models. Details of this work will be published in a coming paper.

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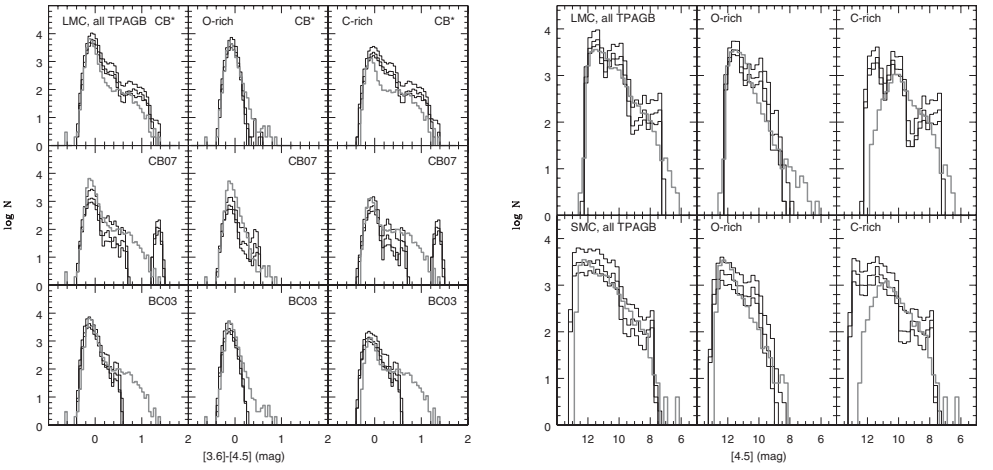

Figure 3. Same as Fig. 2 but for the *IRAC* $[3.6]-[4.5]\mu m$ color distribution (left) and including the results of the simulations for the SMC using the SFH of Harris & Zaritsky (2004) (right).

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