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The effect of binary stars on photometric redshift for galaxies at $z \sim 2.0$

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Abstract. Evolutionary population synthesis (EPS) models play an important role in many studies on the formation and evolution of galaxy. The poorly calibration for some stellar evolution stages in EPS models can lead to uncertainty of the parameter determinations for galaxies. By means of the HyperZ code and a set of theoretical galaxy template, which are built on the EPS models with and without binary interactions, we present photometric redshift (photo-z) estimates for passive galaxy sample at redshift $z \sim 2.0$. The passive galaxy sample is selected from Fang *et al.*, and they also provide the redshift for these passive galaxies. By comparing the photo-z determined from EPS models with and without binary interactions, we find that the binary interactions have little effect in the photo-z determinations.

Keywords. galaxies: stellar content, galaxies: high-redshift, binaries: general.

1. Introduction

The binary stars are very common in nearby star clusters and galaxies. And binary interactions play an important role in evolutionary populations synthesis (EPS) models, they can make the overall shape of the spectral energy distribution (SED) of population to vary, especially, in ultraviolet (UV) passbands they can make the SED of population bluer by $2-3$ magnitude at $t \sim 1$ Gyr. At $z \sim 2.0$, the rest-frame UV emission is shifted to the optical wavelengths, which leads to that the effect of binary interactions is obvious for the observed-frame optical passbands. If the SEDs of galaxies at $z \sim 2.0$ in the observed-frame optical passbands are affected by the binary interactions (Zhang *et al.* 2012, 2013), their photo-z can also be affected. In this study we present the photo-z estimates for passive galaxies at $z \sim 2.0$ based on the HyperZ code and the EPS models with and without binary interactions, and investigate the effect of binary interactions on photo-z determinations.

2. The galaxy sample and method

We adopt the passive galaxies catalogue from Fang *et al.* (2012), which uses the color criteria $g-z$ and $z-K$ to select the passive galaxies from the All-wavelength Extended Groth Strip International Survey (AEGIS). The AEGIS is covers all major wavebands from X-ray to radio and optical spectroscopy over a large area of sky. The photometric data used in this work covers u, g, r, i, z, J, and K bands. Because the spectroscopic redshift data for passive galaxies at high redshift are very rare, in order to check the accuracy of the photometric redshift we derived, we compare our photo-z with that obtained by Fang *et al.* (2012).

In our work, the photo-z is obtained by the HyperZ code of Bolzonella *et al.* (2000), which is the first publicly available photo$-z$ code and has been widely used for photo-z

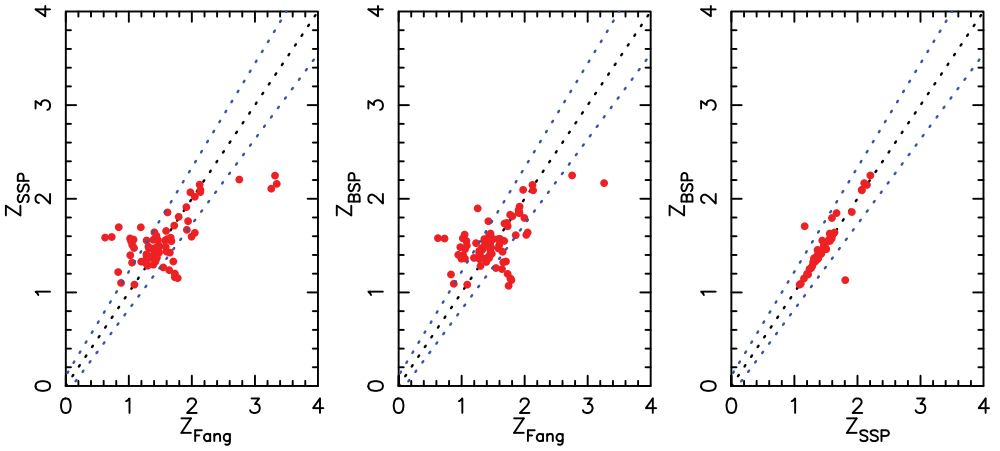

Figure 1. The left and middle panels show the comparisons between Z_{Fang} and Z_{phot} for SSP and BSP models. The right panel give the comparison for Z_{phot} estimated from SSP and BSP models. The blue dotted lines are for $(Z_{SSP/BSP}-Z_{Fang})/(1+Z_{Fang})< 0.1$

estimations of galaxies. HyperZ is based on the standard SED fitting technique and on the detection of strong spectral features, such as 4000Å break, Balmer break, Lyman decrement or strong emission lines.

To check the binary interactions on the determination of photo-z for galaxies, we built theoretical template SEDs using the EPS models with (BSP model, Zhang *et al.* 2005) and without (SSP model, Zhang *et al.* 2004) binary interactions. Both of these models present the SEDs of populations with and without binary interactions. The galaxy template should not only comprise the SEDs of different ages but also include the star formation history. In this work, we built eight types of galaxies: the Burst galaxies with a delta burst SFR, the Irrs with a constant SFR, six types with the following exponentially declining SFR with character time decays, $\psi(t) \propto \exp(-t/\tau)$, where τ and t are the $e-$folding time scale and the age of population, respectively.

3. Result and disscussion

In Fig.1, we display the comparisons between photo-z obtained by Fang *et al.* (2012, Z_{Fang}) and photo-z for SSP (Z_{SSP}) and BSP (Z_{BSP}) models. From these comparisons, we find that the photo-z obtained from SSP and BSP models are in good agreement with Z_{Fang}. In order to investigate the effect of binary interactions on the photo-z estimates, we also compare the Z_{SSP} and Z_{BSP} in the right panel of Fig.1. From the comparison, we see that the photo-z estimates from two models are almost the same, this verify that the binary interactions have no effect on the photo-z determination. Theoretically, the binary interactions can affect the photo-z determination, and we will do further study on this problem.

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