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The effects of binary stars on the colors of galaxies at $z \sim 2.0$

Y. Zhang[1], J. Liu[1] and F. Zhang[2]

[1]National Astronomical Observatories/Xinjiang Observatory, Chinese Academy of Sciences, 150 Science 1-Street, Urumqi, Xinjiang 830011, China
email: zhy@xao.ac.cn
[2]National Astronomical Observatories/Yunnan Observatory, CAS, Kunming, 650011, China

Abstract. Using the Monte Carlo simulations and a set of theoretical galaxy templates, which are built on the Yunnan evolutionary population synthesis models with and without binary interactions, we compare the optical color-color (C-C) relations for passive and star-forming galaxies at redshift $z \sim 2.0$, and study the effect of binary interactions on this relation. We find that the influence of binary interactions on the C-C relation is insignificant for passive galaxies at $z \sim 2.0$.

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

1. Introduction The era at $z \sim 2.0$ is a crucial stage during the cosmic time. During this period, the star forming activity in the Universe and the bulk of stellar mass assembly in galaxies were at their peak levels (Dickinson *et al.* 2003). Binary stars are very common and very important in evolutionary populations synthesis (EPS) models. They can affect the overall shape of the spectral energy distribution (SED) of populations. Especially in the ultraviolet (UV) passbands they make the SED of population bluer by $2-3$ magnitudes at $t \sim 1.0$Gyr. The variation in the SED leads to the uncertainties of parameter determinations for stellar population systems (Zhang *et al.* 2012). Therefore, in this work we will investigate the effect of binary interactions on colors for galaxies at $z \sim 2.0$.

2. Method In this study, we use the standard Yunnan EPS (Yunnan models without binary interactions, SSP, Zhang *et al.* 2004; Yunnan models with binary interactions, BSP, Zhang *et al.* 2005) models and exponentially declining star formation rate (SFR), $\psi(t) \propto exp(-t/\tau)$ (τ is the $e-$folding time scale), to build the theoretical galaxy templates. The $e-$folding time scale is short ($\tau \leqslant 1.0$Gyr, $\tau = 0.001 - 1.0$Gyr) for passive galaxies, while long ($\tau > 1.0$Gyr, $\tau = 2.0, 3.0, 5.0, 15.0$, and 30.0Gyr) for star-forming galaxies. Here, we use Monte Carlo simulations to generate model galaxies and their C-C relation with our galaxy templates.

3. Result By comparing the C-C relations between galaxies based on Yunnan-SSP and -BSP models, we find that there is an effect of binary interactions on the C-C relation for passive galaxies, but the effect is negligible for star-forming galaxies at $z \sim 2.0$.

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