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Modeling low mass stellar populations

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Abstract. Modeling low mass stellar populations, like clusters and dwarf galaxies, with population synthesis models requires that we evaluate the role played by stochastic fluctuations in the sampling of the IMF on the spectro-photometric properties of these sparse populations. Interacting binaries may also modify the integrated spectra of these systems depending on the final product of the binary interaction and on the frequency of binary stars. In this work we compare the relative importance of stochastic fluctuations and binary evolution on low mass galaxy properties as a function of the population age and total mass. In most cases the effects of stochastic fluctuations dominate those produced by binary interactions. We explore and quantify the relative importance of these effects through cosmic times.

Keywords. galaxies: dwarf, galaxies: stellar content, galaxies: fundamental parameters, binaries

1. Model

We obtain the integrated photometric properties of stellar populations by combining the properties derived from the evolution of undisturbed stars, with that of binaries stars close enough to interact at some time of their evolution. In five steps: 1) We calculate the distribution of stellar mass at birth using the stochastic sampling implemented in Charlot & Bruzual (2018, CB18) stellar population synthesis algorithm. 2) From this set of stars we draw the primary and secondary mass of the binary pairs, following the Lada (2006) binary mass distribution and assign them standard binary parameters (period y ellipticity) as in Hernández-Pérez & Bruzual (2013). 3) Using Hurley, Tout & Pols (2012) we follow the evolution of binary stars that interact at some time in the age of the universe. 4) The evolution of undisturbed stars are calculated with CB18 following the PARSEC (Bressan *et al.* 2012) evolutionary tracks. 5) The spectrophotometric properties of both populations are derived from BaSeL 3.1 (Westera *et al.* 2002) stellar library using CB18 algorithm.

2. Results and Conclusions

Figure 1 summarizes the results of our simulations.

Dispersion in the optical and infrared colors due to stochastic fluctuations of the IMF are comparable with the effect that interacting stellar pairs produce in the integrated galaxy spectrum. The bias and dispersion are comparable with that produced by an uncertainty in age of 0.1 dex and is noticeable for low total mass stellar systems.

Far ultraviolet colors for aged populations (age $\geqslant 10^9$ yr) of arbitrary mass are strongly affected by the evolution of interacting binaries. At 10 Gyr, median FUV-r is ≈ 1.5 mag bluer than the standard model with a dispersion that decrease with total mass.

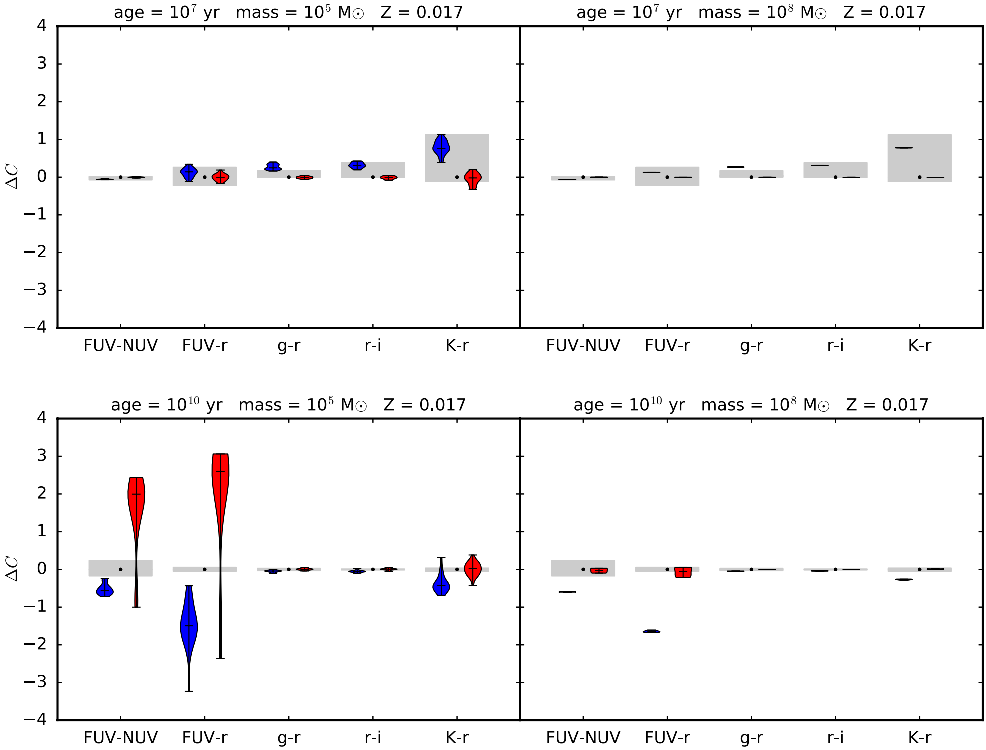

Figure 1. Violin plot of the distribution of $\Delta C \equiv$ *stochastic color* $-$ *standard color*. *stochastic color* is the color of 30 model realizations of a stochasticly sampled Kroupa (2001) IMF with (blue, left) or without (red, right) interacting binaries, and *standard color* is the color of the model with the IMF calculated with the analytical prescription. Grey boxes enclose the range of color for *standard model* at indicated age ± 0.1 dex.

For low stellar mass ensambles ($M \leqslant 10^7 M_\odot$) of age ≈ 10 Gyr, far ultraviolet colors of undisturbed, stochastically sampled, stars show a huge dispersion, mainly redder than standard model values. For $10^5 M_\odot$, the median FUV-r is 2.5 mag redder than standard model with a dispersion greater than 4 mag.

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