The bright end of the colour-magnitude relation of cluster galaxies

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(Submitted on 4 Jul 2011)

We investigate the development of the red sequence (RS) of cluster galaxies by using a semi-analytic model of galaxy formation. Results show good agreement between the general trend of the simulated RS and the observed relation in early-type galaxies. However, the most luminous galaxies ($M_V \lesssim -20$) depart from the linear fit to observed data, displaying almost constant colours. We analyze the dependence with redshift of the fraction of stellar mass contributed to each galaxy by different processes (i.e., quiescent star formation, disc instability and mergers), finding that the evolution of the bright end, since $z\approx 2$, is mainly driven by minor and major dry mergers. Since the most luminous galaxies have a narrow spread in ages (1.0×10^{10} yr $<t<1.2\times 10^{10}$ yr), their metallicities are the main factor that affects their colours. Galaxies in the bright end reach an upper limit in metallicity as a result of the competition of the mass of stars and metals provided by the star formation within the galaxies and by the accretion of merging satellites. Star formation activity in massive galaxies (M_\star \gtrsim 10^{10} M_{\odot}$) contribute with stellar components of high metallicity, but this fraction of stellar mass is negligible. Mergers contribute with a larger fraction of stellar mass ($\approx 10-20$ per cent), but the metallicity of the accreted satellites is lower by ≈ 0.2 dex than the mean metallicity of galaxies they merge with. The effect of dry mergers is to increase the mass of galaxies in the bright end, without significantly altering their metallicities, and hence,their colours, giving rise to the break in the RS. These results are found for clusters with different virial masses, supporting the idea of the universality of the CMR in agreement with observational results.

Comments: 18 pages,7 figures,1 table. Accepted for publication in MNRAS
Subjects: **Cosmology and Extragalactic Astrophysics (astro-ph.CO)**
Cite as: **arXiv:1107.0722 [astro-ph.CO]**
(or **arXiv:1107.0722v1 [astro-ph.CO]** for this version)

Submission history

From: Noelia Jimenez [view email]
[v1] Mon, 4 Jul 2011 20:00:02 GMT (202kb)

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