The Effect of the Cluster Environment on Galaxy Transformations

Pierluigi Cerulo
(pcerulo@astro-udec.cl)
Department of Astronomy, Universidad de Concepción

Abstract

- Clusters of galaxies are fundamental for the study of the environmental drivers of galaxy evolution. We use a sample of 9 massive galaxy clusters at redshifts $\mathbf{0.8 < z < 1.5}$ drawn from the HAWK-I Cluster Survey (HCS, [Lidman et al.(2013)]) to study the effect of environment on the transformations of galaxy properties. We focus in particular on the transition from the star-forming to quiescent regimes (the build-up of the red sequence) and on the investigation of the evolutionary paths of galaxies with different morphologies.

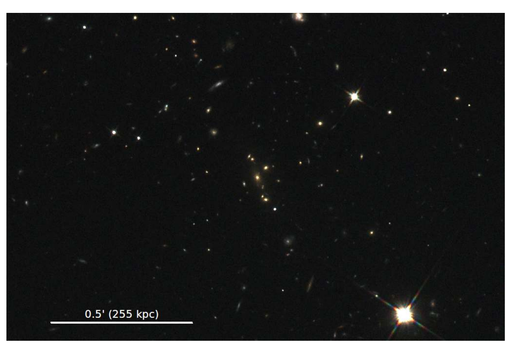
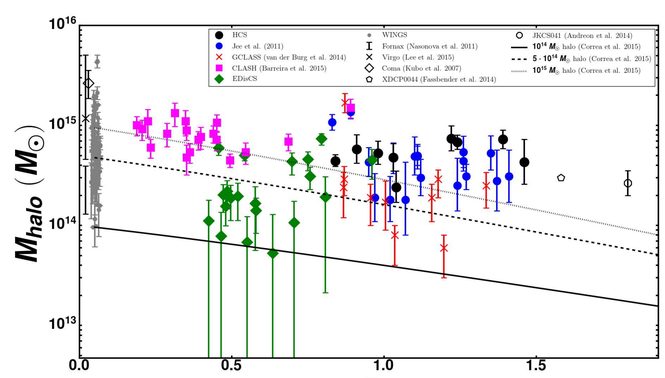


Figure 1: The HCS cluster XMMU J2235.3-2557 at $\mathbf{z = 1.39}$.

- Right: the HCS sample (filled black symbols) compared with other cluster samples from the literature and tracks from the predictions of halo mass accretion. HCS clusters are among the most massive structures at their redshifts and likely to evolve into Coma-like clusters.



The Build-up of the Red Sequence (Cerulo et al. 2016, Cerulo et al. in preparation)

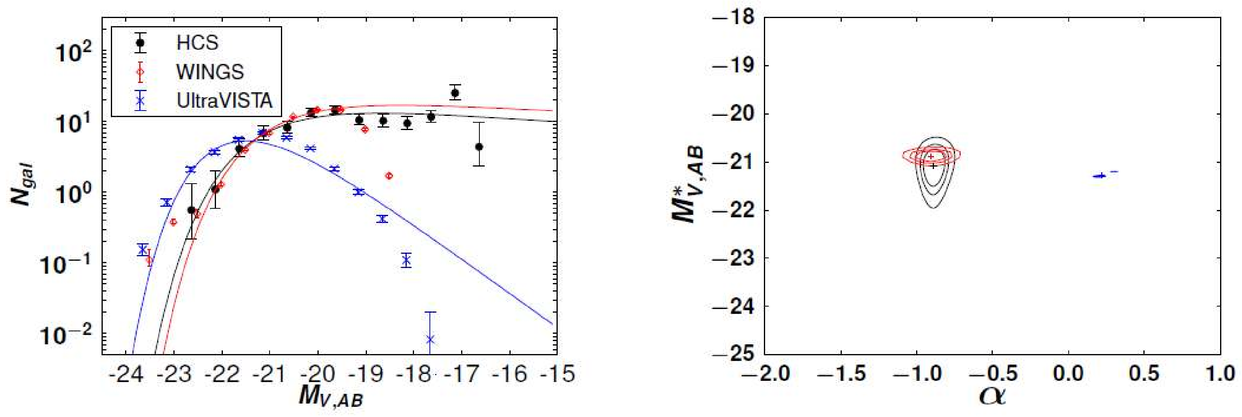


Figure 2: Red sequence luminosity distribution.

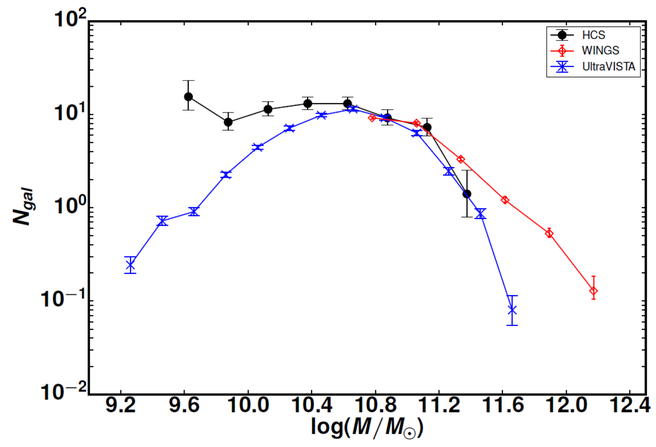
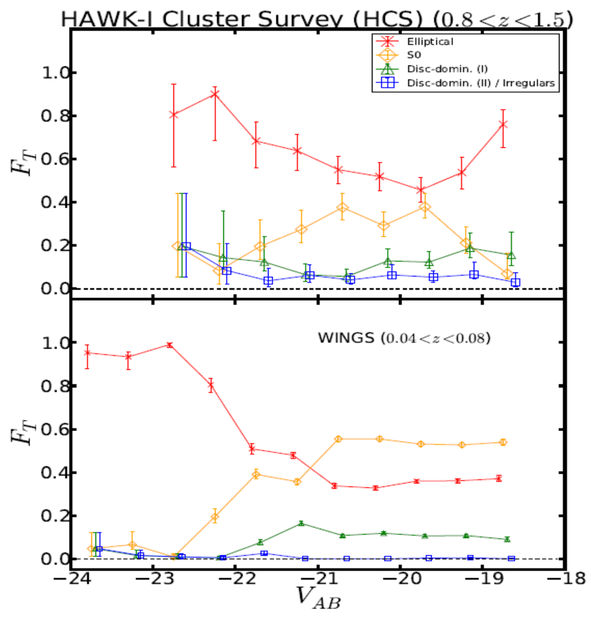


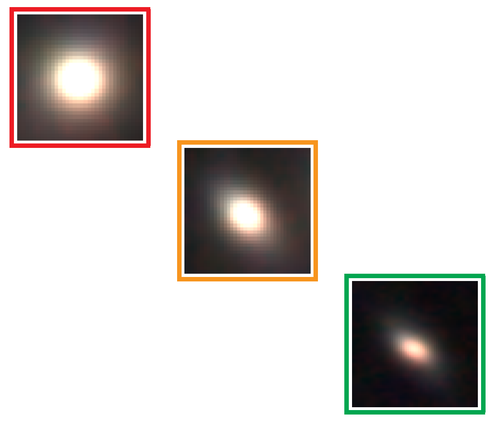
Figure 3: Red sequence stellar mass distribution

- The HCS red sequence undergoes an accelerated build-up with respect to less dense environments at the same redshifts. We find that the red sequence number counts for the HCS clusters (black symbols) as a function of $\mathbf{M_V}$ absolute magnitude (top-left) show no significant difference at the faint end with respect to the low-redshift clusters of WINGS (red symbols). However, we find that the field red sequence number counts in the COSMOS/UltraVISTA sample (blue symbols), measued at $\mathbf{0.8 < z < 1.5}$, exhibit a downturn at faint magnitudes. This latter trend is also seen in the number counts as a function of stellar mass (right-hand panel). Our results suggest that the halo mass of the hosting large scale structure may play an important role in determining the timescales for star formation quenching in galaxies [Cerulo et al.(2016)].

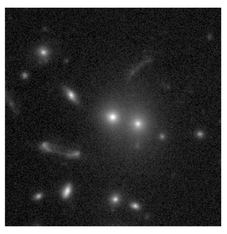
Morphological Transformations of Red Sequence Galaxies (Cerulo et al. 2016 in preparation)

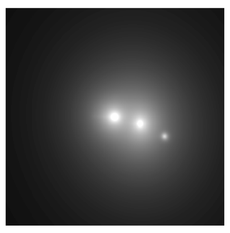
- The red sequence in both the HCS (top) and WINGS (bottom) clusters is dominated by early-type galaxies. However, we find that elliptical galaxies (red symbols) are the predominant morphological type at high redshifts at all luminosities, while at low redshift S0 galaxies (orange symbols) become the dominant population on the red sequence at magnitudes fainter than $\mathbf{M^*_V}$. At all redshifts late-type galaxies (early- and late-type discs and irregulars, green and blue symbols, see [Cerulo et al.(2014)]) represent the minority of the red sequence population.
- This result suggests that the evolutionary paths of cluster ellipticals and lenticulars differ and, in particular, that the S0 galaxies at low redshift may be the descendant of spiral galaxies which landed on the red sequence after ceasing star formation and then transitioned to a S0 morphology.
- Candidate processes for such a transformation may be disc fading, and tidal interactions with neighbouring galaxies.

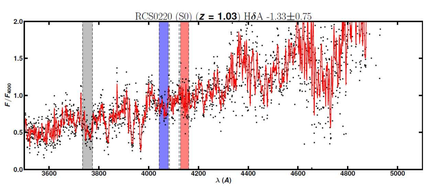


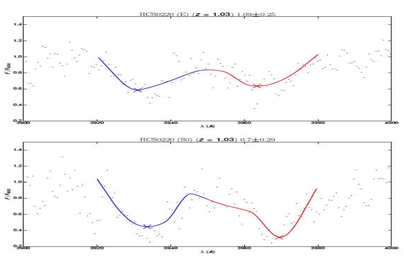


Work in Progress: How is the environment affecting the properties of galaxies?









- To answer this question we have undertaken a simultaneous study of galaxy structure and stellar populations in HCS and other publicly available cluster data-sets (see also [Nantais et al.(2013a), Nantais et al.(2013b)]). The four figures show examples of light profile fitting for two massive ellipticals (left) and two age-sensitive spectral diagnostics, namely the Hδ absorption line and the (Ca H+Hϵ) /(Ca K) line ratio (right).

REFERENCES

- Cerulo et al., 2014, MNRAS, 439, 2790
- Cerulo et al., 2016, MNRAS, 457, 2209
- Lidman et al., 2013, MNRAS, 433, 825
- Nantais et al., 2013a, A&A, 556, C4
- Nantais et al., 2013b, A&A, 556, A112