The Cluster 1001 detected in miniJPAS: Paving the way for galaxy evolution studies in J-PAS

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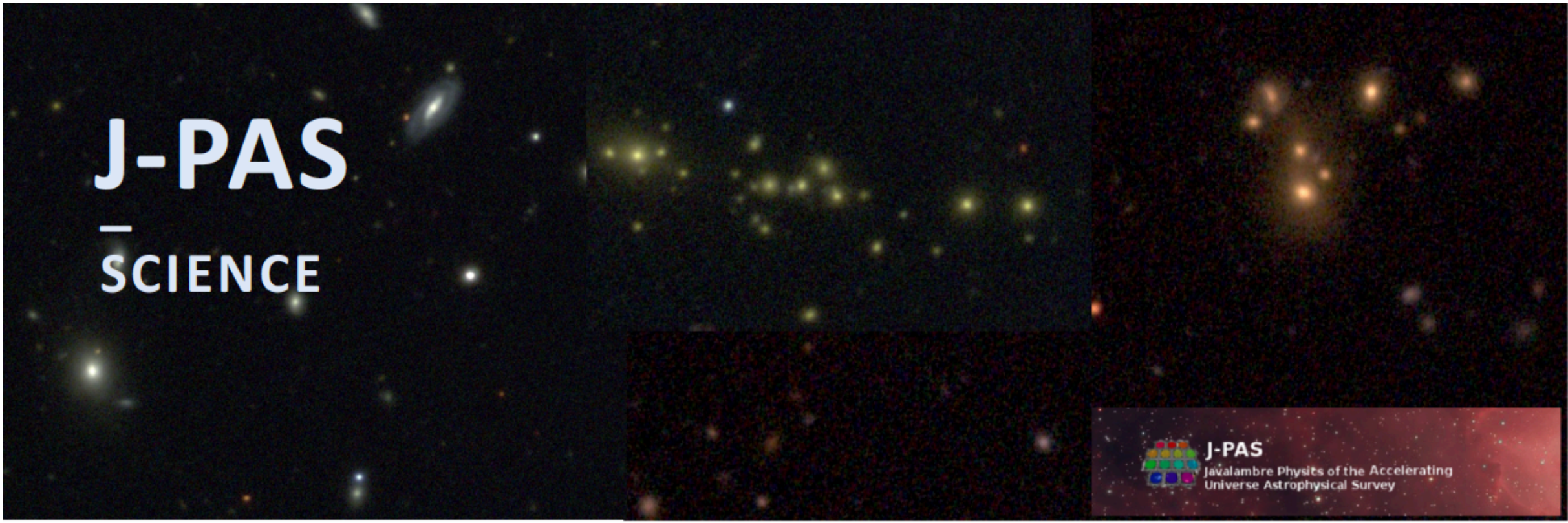
The Javalambre-Physics of the Acclerating Universe Asptrohysical Survey (J-PAS) have just started to scan thousands of square degrees of the northern sky with 54 narrow band filters and the JPCam instrument with the telescope 2.5m of the Javalambre Observatory. Before the JPCam started its operation, we have observed with the Pathfinder camera one square degree on the AEGIS field (along the extended Groth Strip). Thanks to its large field of view and its spectral resolution comparable to the one of a very low resolution spectroscopy, it brings a great opportunity to study the stellar population properties of the galaxies belonging to a cluster. We used the data obtained for the Cluster 1001 to study its properties. In particular, we consider the mass-weighted age, the stellar mass, the extinction (A_v), the metallicity and the SFH to find out if the star formation has been quenched in the galaxies of the cluster. We also use the criteria given by Díaz-García et al. (2019) to separate galaxies into red galaxies and blue galaxies. Our results show a fraction of 0.53 for red galaxies and 0.47 for blue galaxies. We find that most of the red galaxies are the closest ones to the main brightest galaxy of the cluster, while most of the blue galaxies draw a line in the sky. Our results show that most of the galaxies present high values for t_0 (the time at which the star formation started) and low values of τ for red galaxies. Further works studying the effects of the environment in the galaxy evolution will be carried out for groups and clusters detected in J-PAS.

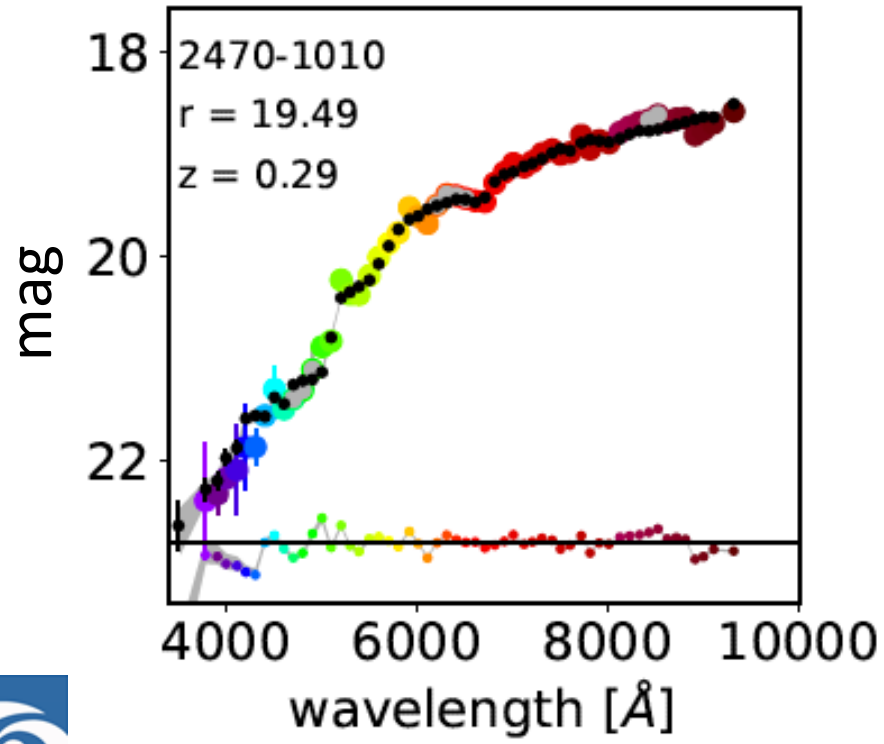
1. Context of the research

This work is a collaboration between the Galaxy Evolution group and the Clusters science working groups of J-PAS. J-PAS provides a very useful tool not only for cosmology, but also for studying the effects of the environment in the galaxy evolution, in particular for studying the main mechanisms that stop the star formation in the galaxies members of clusters and groups. J-PAS is a powerful survey to detect clusters and groups at intermediate redshift. This figure illustrate the detection of several groups and the cluster 1001 that is shown at the center of the image.



Galaxy Evolution: the J-PAS survey

- We studied the stellar population properties of 96 of the 99 galaxies of the Cluster 1001.
- BaySEAGal (de Amorim et al., in prep.): a bayesian inference code for spectral fitting using the data from the 56 narrow band filters
- We derive the rest-frame and intrinsic colors following Díaz-García et al. (2019) to separate blue and red galaxies by:
  (u-r) = 0.16*(log(M) – 10) – 0.3*(z- 0.1)+1.7



delayed-tau SFH

$$\psi(t) = \frac{A}{\tau^2}(t_0 - t)e^{-(t_0-t)/\tau}$$

Parametric spectra

Magnitudes in filter bands expanded as Taylor series on the parameters.

$$L_\lambda(\Theta) = 10^{-0.4 q_\lambda A_V} \int \Psi(t;\Theta) f_\lambda(t, Z)\, \mathrm{d}t$$

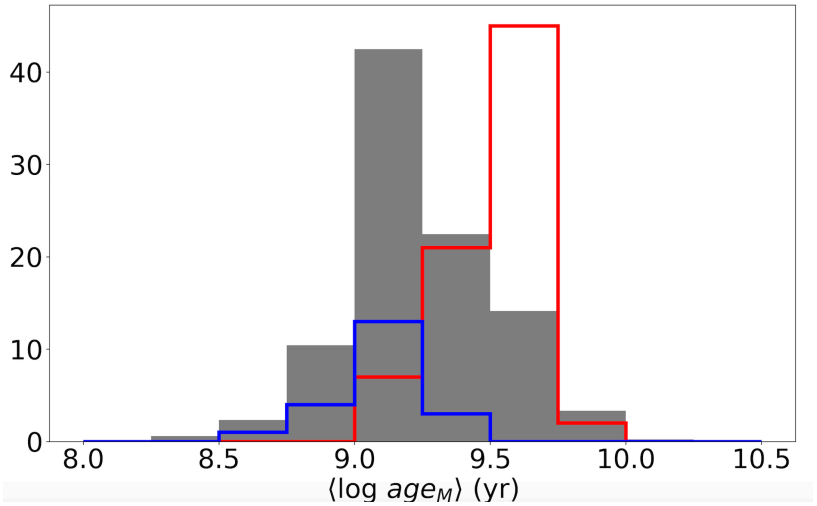
Fitting:

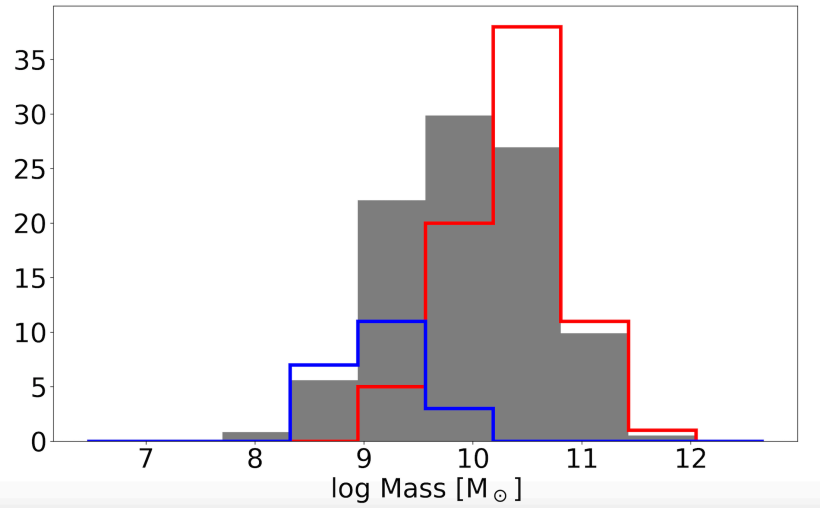
$$\chi^2_{\mathrm{mag}} = \sum_{j=1}^{N_{\mathrm{mag}}} \left(\frac{O_j - M_j(1M\odot) + 2.5 \log \frac{M_\star}{M_\odot}}{w_j} \right)^2$$

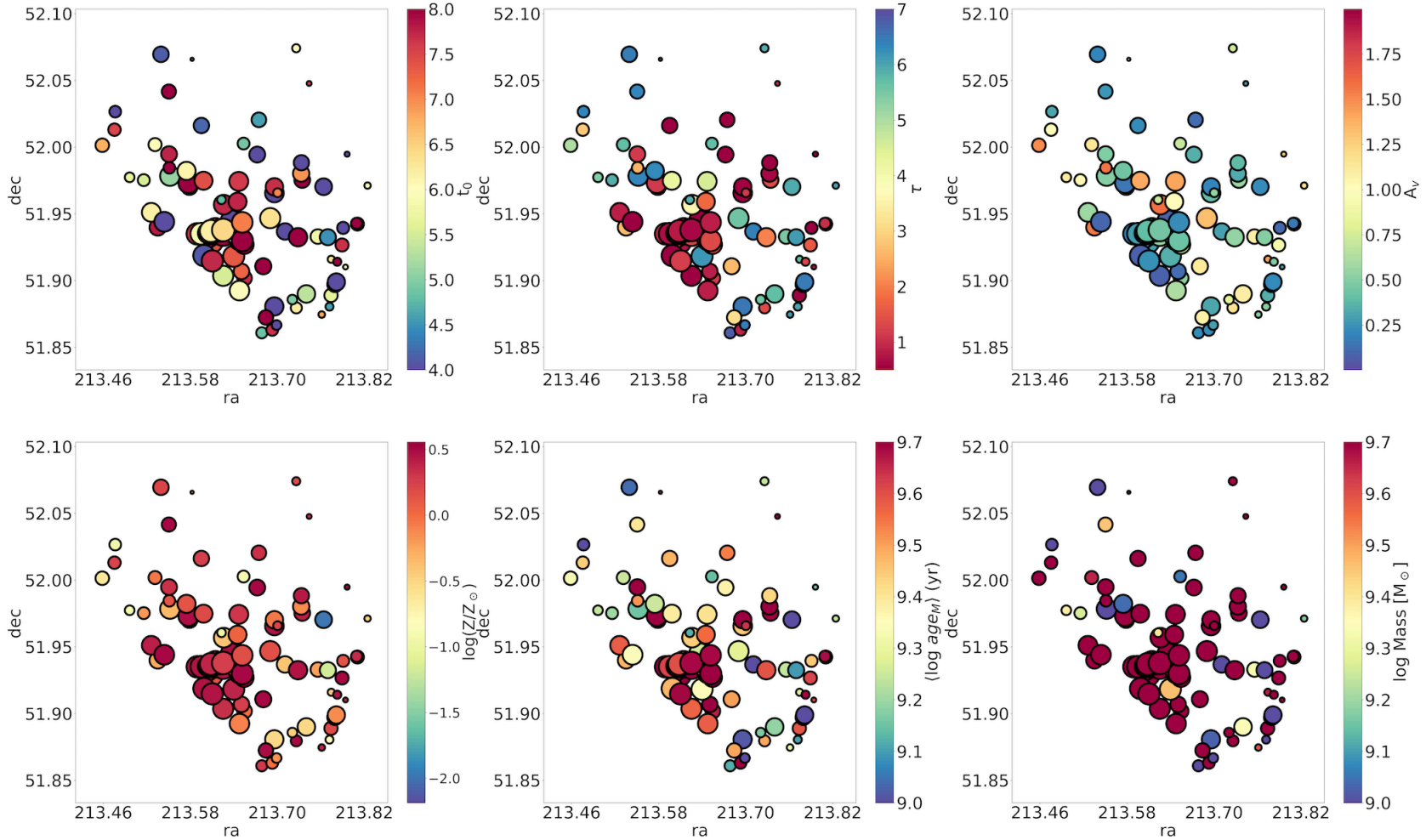
Parameters:

$$\langle t_0 \rangle = \sum_{t_0} p(t_0|O)\, t_0; \quad \sigma^2_{\langle t_0 \rangle} = \sum_{t_0} p(t_0|O)\, [\langle t_0 - \langle t_0 \rangle$$

$$\langle \tau \rangle = \sum_{\tau} p(\tau|O)\, \tau; \quad \sigma^2_{\langle \tau \rangle} = \sum_{\tau} p(\tau|O)\, [\langle \tau - \langle \tau \rangle]$$

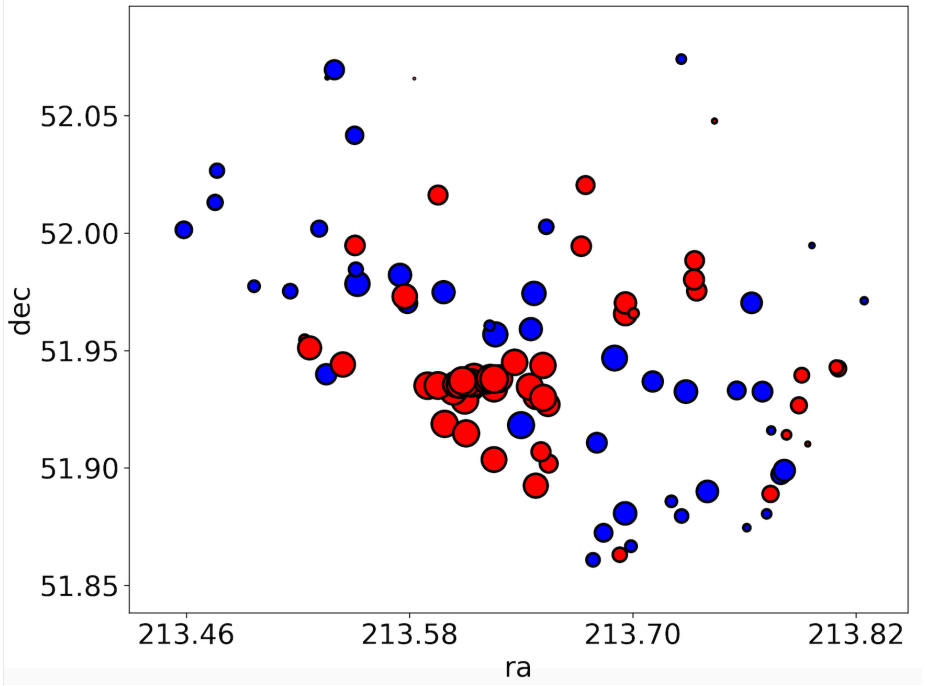






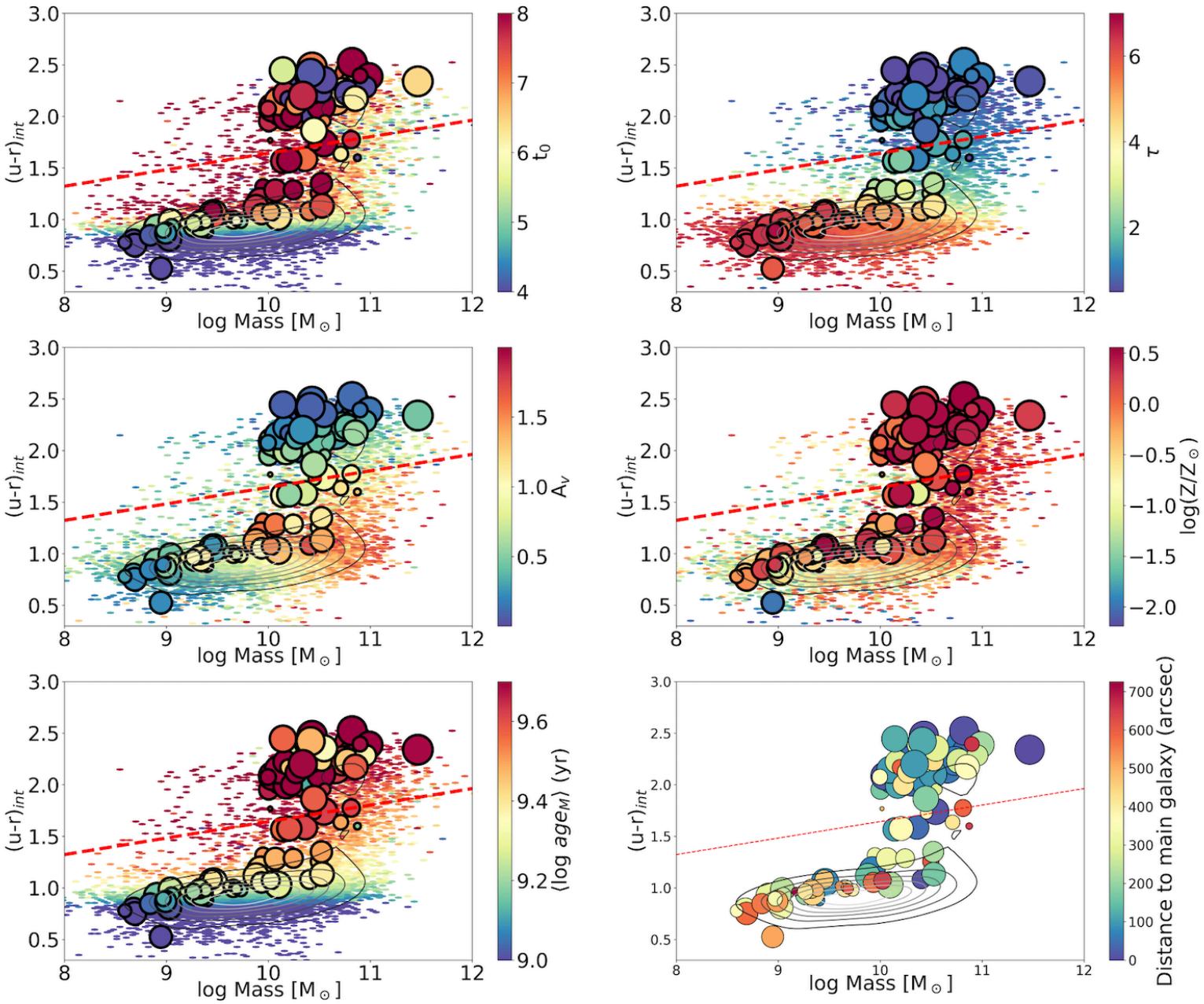
Left: Mass and mass-weighted age histograms. Grey solid histograms represent all the histogram that would be obtained if the number of observed with JPAS was equal to the number of galaxies in the cluster. Red histograms represent red galaxies and blue are the blue galaxies in the cluster

Right: Spatial distribution of the stellar population properties of the galaxies belonging to the cluster. The dot size represents the probability of being part of the cluster.



Up: Spatial distribution of the galaxies. Dot size represents the probability of belonging to the cluster. Red dots represent red galaxies attending to out classification, and blue dots represent blue galaxies.

Right: stellar properties of the galaxies in the cluster in the u-r intrinsic color vs mass diagram. Dot size represents the probability of belonging to the cluster. Galaxies above the red line are considered to be red, while galaxies under it are considered to be blue. The smaller, unmarked points represent the values of all the galaxies observed with JPAS.

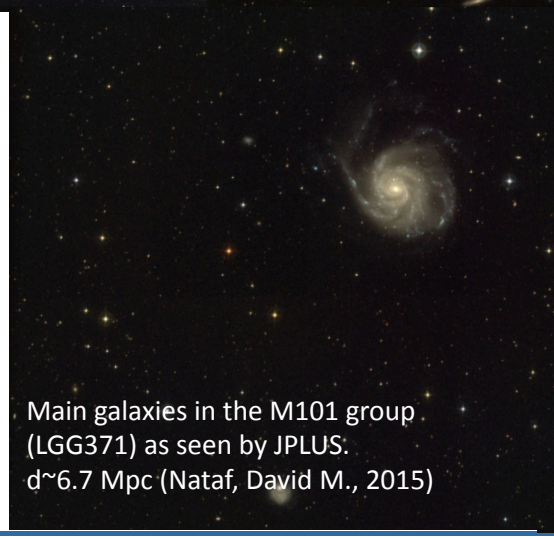


4. Impact and prospects for the future

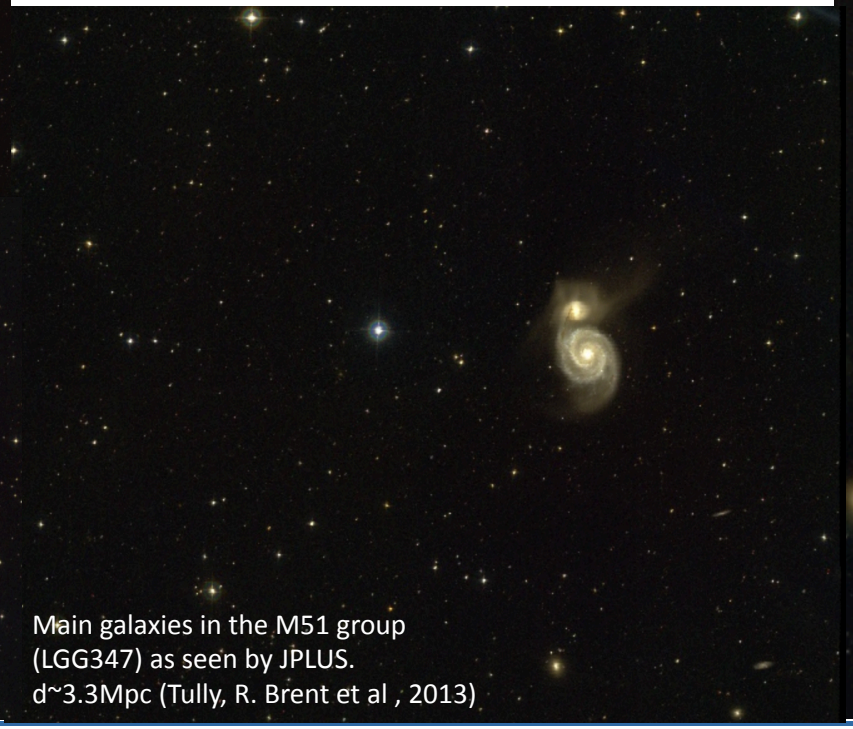
This work is the first step in further studies on the effect of the environment in the galaxy evolution of galaxy groups and clusters. The closest galaxy groups will be part of Rodríguez-Martín's PhD thesis (using also JPLUS data), while mid and far clusters and groups will be studied by the JPAS collaboration.

Local groups as seen by JPLUS (Cenarro, A.J. et al, 2019)

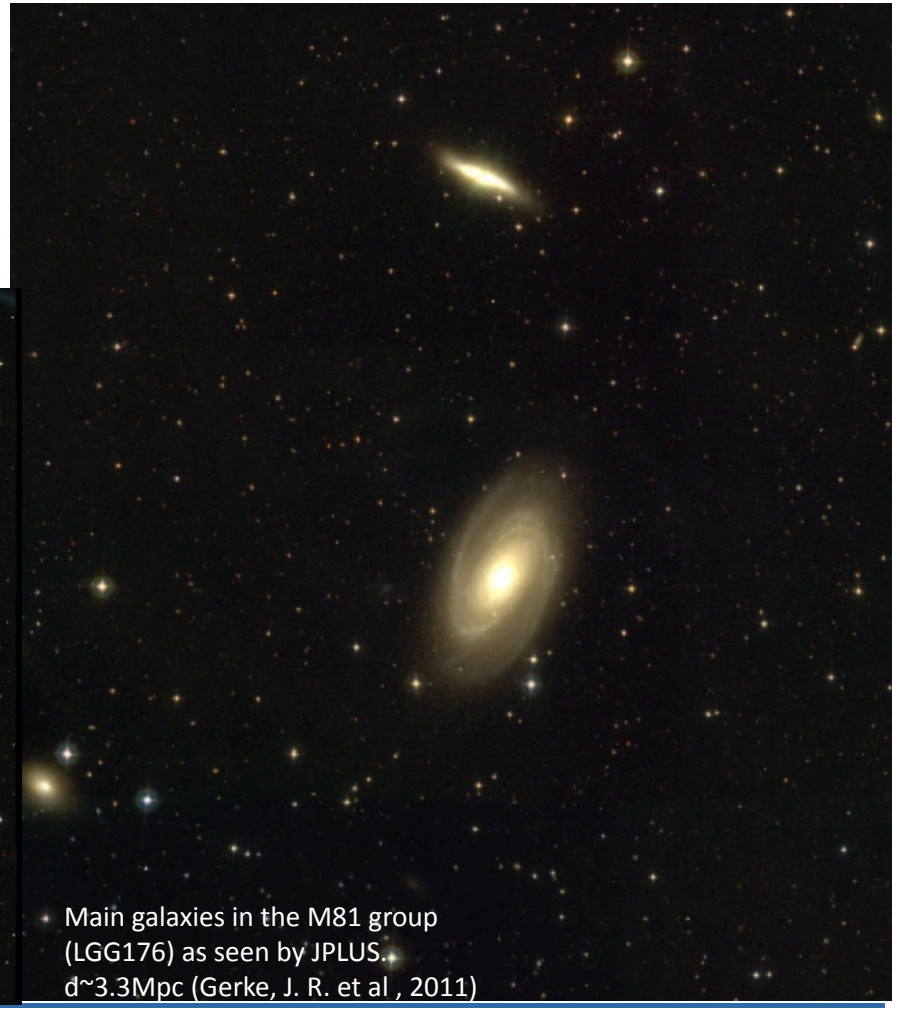
Main galaxies in the LGG290 group as seen by JPLUS.
d~7.0Mpc (Efstathiou, George, 2014)



Main galaxies in the M101 group (LGG371) as seen by JPLUS.
d~6.7 Mpc (Nataf, David M., 2015)



Main galaxies in the M51 group (LGG347) as seen by JPLUS.
d~3.3Mpc (Tully, R. Brent et al , 2013)



Main galaxies in the M81 group (LGG176) as seen by JPLUS.
d~3.3Mpc (Gerke, J. R. et al , 2011)