Galaxy And Mass Assembly (GAMA): the interplay between mass, metallicity and SFR in galaxy groups

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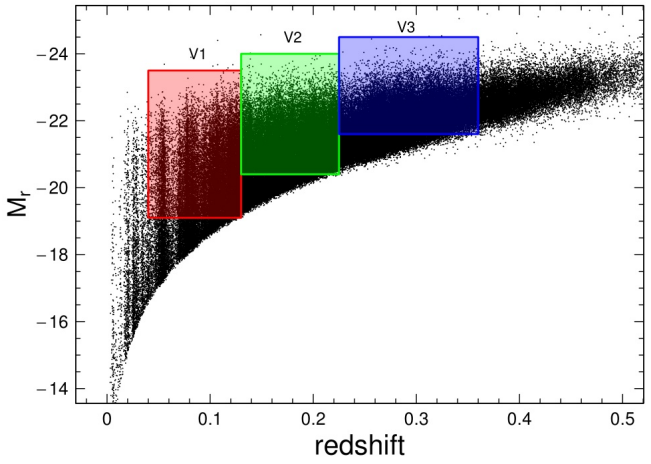
The environmental dependence of fundamental properties of galaxies will give us a general picture of the physics and feedback processes ongoing in groups of galaxies. We analyzed the relationships and environmental dependencies between the stellar mass and gas metallicity and star formation for more than 700 galaxies in groups up to redshift 0.35 using the GAMA survey. We determined variations by using control samples of more than 16000 star-forming field galaxies. We find (s)SFR and metallicity variations as a function of the distance to the group center, group mass and local density

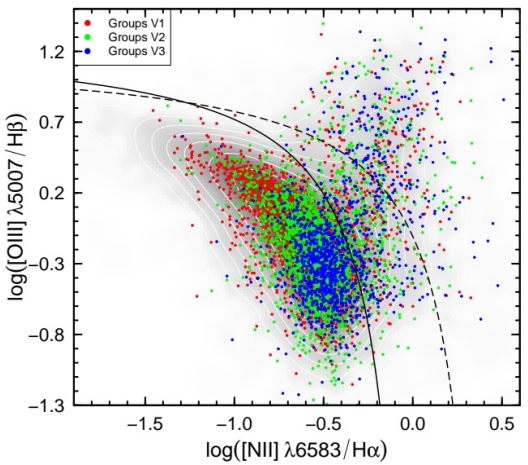
Nature vs Nurture, what drives the evolution of galaxies?

- Large statistical sample of group sample from the GAMA* survey (Robotham et al. 2012)
- Proper comparison between field and group galaxies to characterize the factors that play a role in their evolution affecting properties as their metallicity or star formation rates
- Some of the previous studies have found higher metallicities in cluster galaxies when compared to the field (Ellison et al. 2009) The role of the environment in the star formation activity is unclear: Lilly et al. (2007) found a reduced SFR in cluster galaxies with respect to similar galaxies (in mass and redshift) from the field, while Peng et al. (2010) found no dependence on the environment

- Comparison of properties:
  - Mass-Metallicity (M-Z) relation
  - Mass-Star formation rate (M-SFR) relation
  - Mass-Specific SFR (M-sSFR) relation

- Selected galaxies
  - Three volume limited samples
  - Star forming galaxies
  - Only groups with more than 5 galaxies
  - Signal/Noise > 3 for Hα, Hβ, NII and OIII
  - Final sample formed mainly by late type galaxies





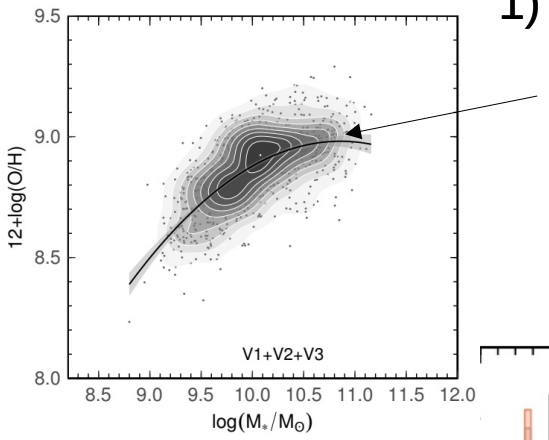
- *Galaxy And Mass Assembly (GAMA, Driver et al. 2009). Wide-area dataset for low to intermediate redshift galaxies

Methodology

- Comparison between group galaxies and control field galaxies
  - Same distribution in mass and redshift as the group sample: mitigates side-effects of redshift and mass variations

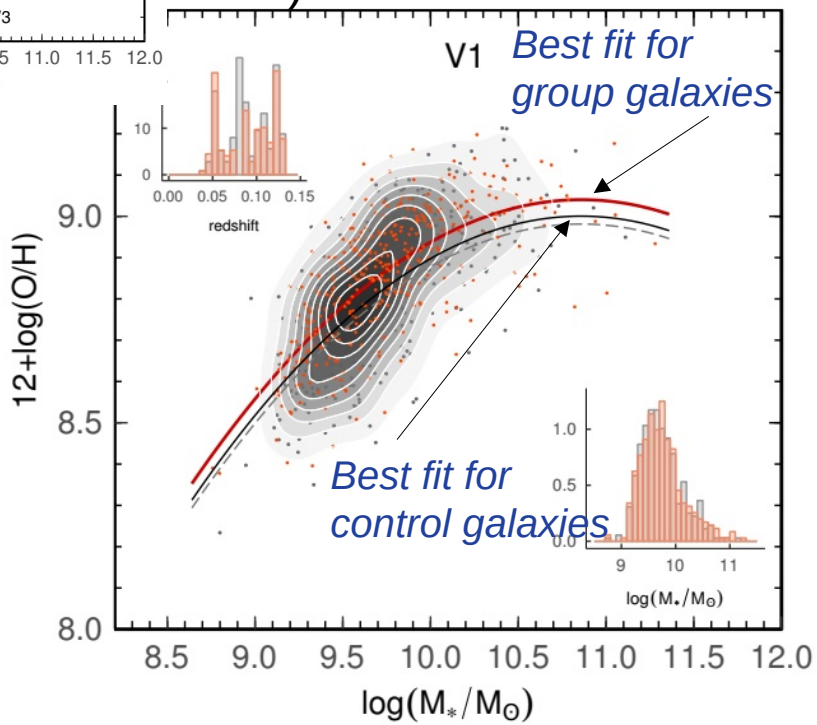
- Procedure
  1) Polynomial fit to all three control samples combined
  2) Fit the zero point to individual group and control samples
  3) Calculate difference between group and control
  4) Error bars: bootstrap

1)



Best polynomial fit for all three control samples

2)

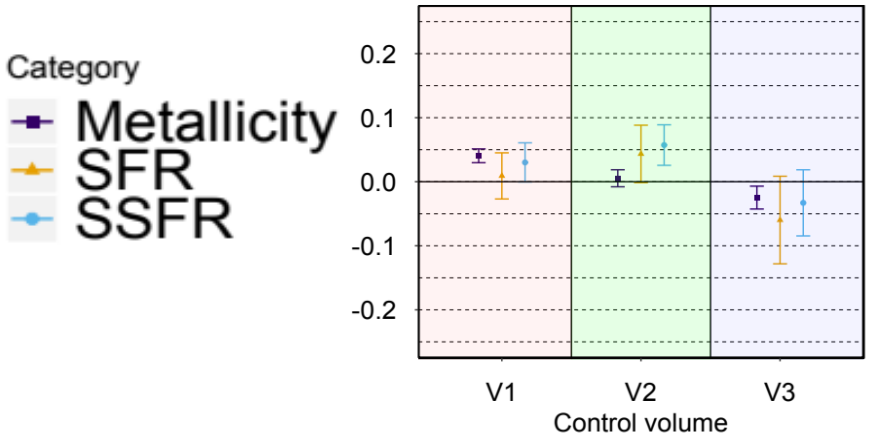


Best fit for group galaxies

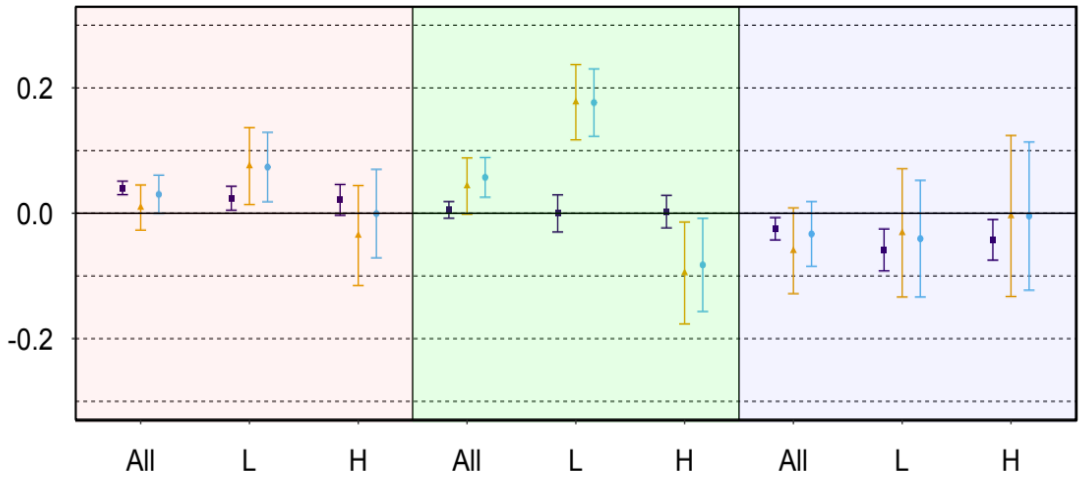
Best fit for control galaxies

Results

- Metallicity: difference increases with decreasing redshift (V1: 0.040-0.130)
- (s)SFR: peak in V2 (redshift range 0.130-0.225)

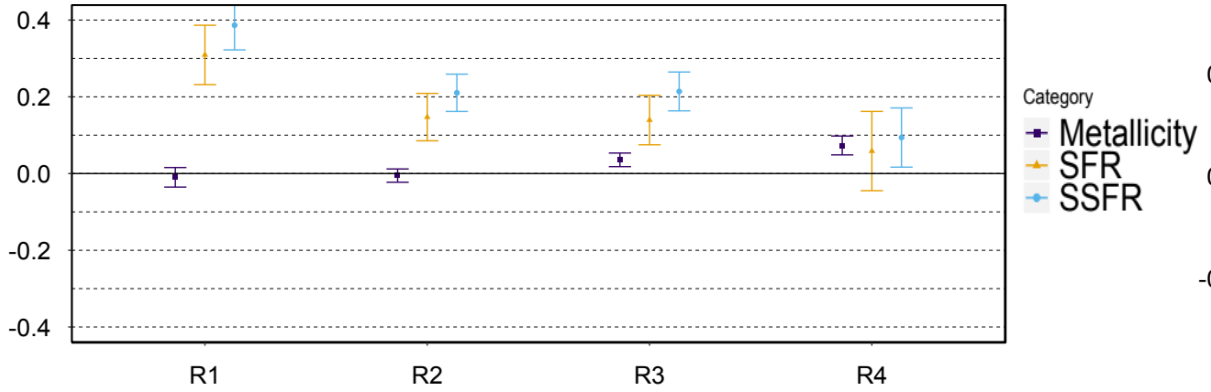


- Low (L) and high (H) mass galaxies:
  - Metallicity: no significant differences for the low and high mass subsamples
  - (s)SFR: increases for low mass galaxies, decreases for high mass galaxies (unclear for V3: smaller sample)
  - * below first quartile (L) and above third quartile (H)



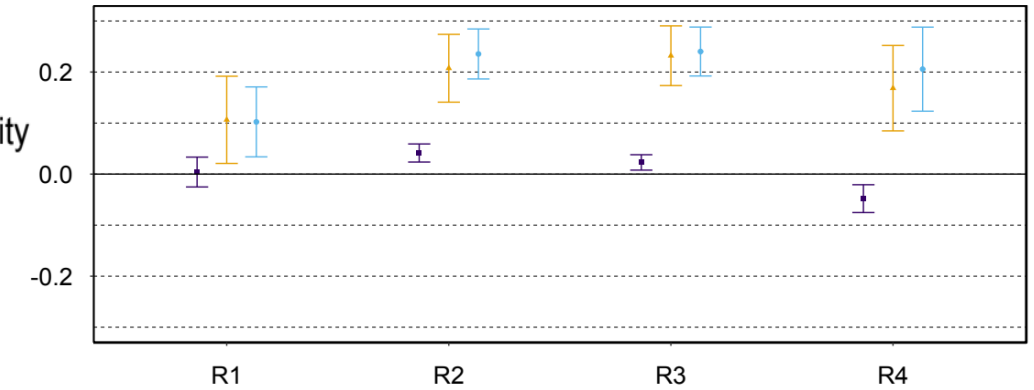
Results: all three volumes combined

- Galaxy number density



- Metallicity: small variations, increasing with density up to ~0.8 dex for the highest sigma bin.
- SFR (and sSFR): enhanced SFRs in group galaxies for all the Σ_5 bins, decreasing with increasing surface density

- Group-centric distance



- Metallicity: small variations, with a maximum difference of ~ -0.05 dex for galaxies in the more distant bin.
- SFR (and sSFR): increase with group-centric distance, up to maximum corresponding to the bin with range 0.25 – 0.63 Mpc

Impact and prospects for the future

- We find that gas metallicity increases for galaxies in high dense environments, and decreases for galaxies at large distances from the center
- Previous authors find that the SFR is suppressed near the center of groups and clusters (e.g., Couch et al. 2001, Barsanti et al. 2018). Our results indicate however, that late-type galaxies show a small clear increment of 0.1 dex for the most central group galaxies in our sample
- Try to reproduce our results using the IllustrisTNG simulations
- Publish the results