

Environmental effects on star formation main sequence in the COSMOS field

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Abstract. We investigate the relationship between environment and star formation main sequence (the relationship between stellar mass and star formation rate) to shed new light on the effects of the environments on star-forming galaxies. We use the large VLA-COSMOS 3 GHz catalogue that consist of star-forming galaxies (SFGs) and active galactic nuclei (AGN) in three different environments (field, filament, cluster) and for different galaxy types. We examine for the first time a comparative analysis for the distribution of SFGs with respect to the star formation main sequence (MS) consensus region from the literature, taking into account galaxy environment and using radio selected sample at $0.1 \leq z \leq 1.2$ drawn from one of the deepest COSMOS radio surveys. We find that, as observed previously, SFRs increase with redshift independent on the environments. Furthermore, we observe that SFRs versus M_* relation is flat in all cases, irrespective of the redshift and environments.

Keywords. Galaxies: evolution, galaxies: star-forming, galaxies: environment, galaxies: stellar mass, galaxies: star formation rate

1. Overview

We use a multi-wavelength counterpart catalogue based on the VLA-COSMOS 3 GHz Large Project compiled by [Smolčić *et al.* \(2017\)](#). We matched this catalogue to the cosmic web environment catalogue of [Darvish *et al.* \(2015, 2017\)](#) in aiming to study the effects of the environment (field, filament, cluster) on star formation main sequence for various type of galaxies (satellite, central, isolated). After that we then matched the later catalogue to the COSMOS2015 of [Laigle *et al.* \(2016\)](#) to obtain stellar mass (M_*) and photometric redshifts (z) for each galaxy (bad data, i.e. FLAG = 1 as in COSMOS2015, were all discarded).

We apply the SFGs/AGN separation criteria of [Smolčić *et al.* \(2017\)](#) to further select AGN. The sample utilises the classified AGN/SFGs of [Smolčić *et al.* \(2017\)](#) which consists of X-ray, MIR, and SED-based and plus a combined rest-frame colour with radio excess diagnostics where it is known as "clean" classification.

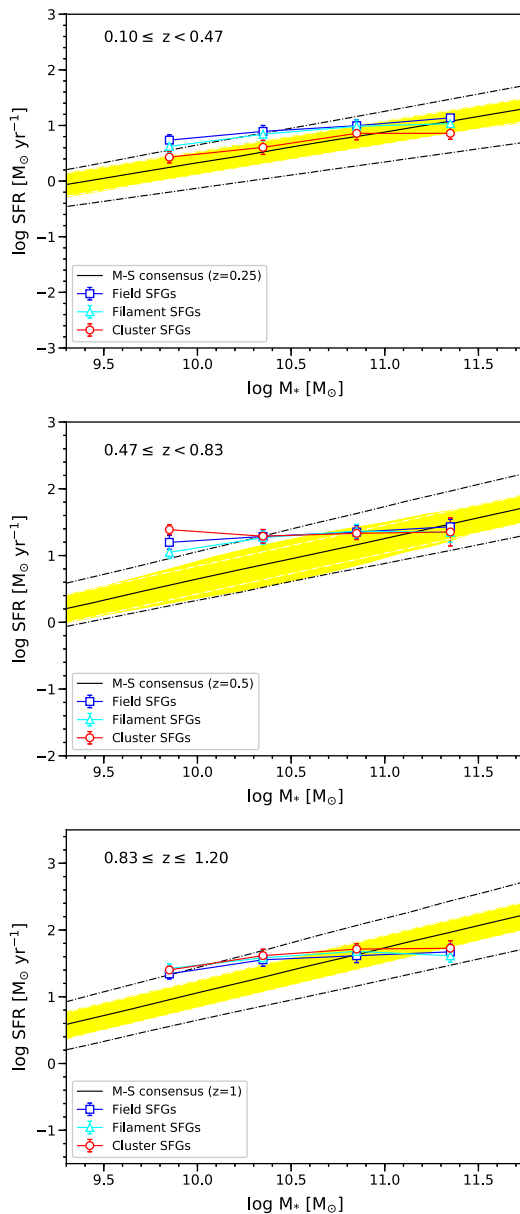


Figure 1. Star formation rate (SFR) against stellar mass (M_*) of SFGs for the three different environments for the lower redshift (*top panel*), intermediate (*middle panel*), and higher (*bottom panel*) redshift bins. The black solid line of each panel indicates the best-fit MS consensus of Speagle *et al.* (2014) at $z=0.25$ (*top*), $z=0.5$ (*middle*), and $z=1$ (*bottom*) while the shaded yellow region indicates a scatter of ± 0.2 dex consensus dispersion. The black dashed-dotted lines indicate MS consensus of Speagle *et al.* (2014) at $z=0$ and 0.5 (*top*), $z=0.25$ and 1 (*middle*), and $z=0.5$ and 2 (*bottom*), respectively, which are shown as benchmark for comparison. Each panel presents the behaviour of the average M_* of the four M_* bins for the three environments. Blue square, teal triangle, and red circle represent field, filament, and cluster SFGs. Error bars correspond to average 1σ errors based on the standard error of the mean.

The final number of sources out of these selection procedures resulted to 2568 galaxies where 1836 are SFGs and 732 are AGN. We indicate that we entirely focus on studying for the SFGs only throughout the paper (i.e. we removed AGN from our sample).

2. Properties of galaxies

The stellar mass (M_*) were estimated based on spectral energy distribution (SED) fitting using the stellar population synthesis model of Bruzual & Charlot (2003) templates by assuming an initial mass function (IMF) of Chabrier (2003). The full details of the method for measuring the (M_*) is presented in Laigle *et al.* (2016).

The star formation rates (SFRs) were inferred from the total infrared luminosity by using the Kennicutt (1998) conversion factor that were scaled to a Chabrier (2003) IMF. The full details of the method for measuring the total infrared luminosity and SFR is presented in Smolčić *et al.* (2017).

We note that measurements of galaxy environments and types are based on density field Hessian matrix and we refer the readers to the work of Darvish *et al.* (2015, 2017) for full details.

3. Results

Figure 1 shows the behaviour of the MS as a function of the average M_* for four M_* bins. Each panel presents the behaviour of the average M_* of the four M_* bins for the three environments. Blue square, teal triangle, and red circle represent field, filament, and cluster SFGs. Error bars correspond to average 1σ errors based on the standard error of the mean.

We observe that the MS for all SFGs do not agree with the yellow region from the MS consensus and plus they all have shallower slopes in all environments.

4. Summary

In this paper, we present a study of the relationship between environment and star formation main sequence to shed new light on the effects of the environments (field, filament, cluster) on galaxies.

We summarise our main results as follows: (i) as observed previously, we find that SFRs increase with redshift independent on the environments; (ii) Furthermore, we observe that SFRs versus M_* relation is flat in all cases, irrespective of the redshift and environments.

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