Enhanced Star Formation of Less Massive Galaxies in a Proto-Cluster at $z = 2.5$

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We investigate a correlation between star-formation rate (SFR) and stellar mass for Hα emission line galaxies (HAEs) in one of the richest proto-clusters ever known at $z \sim 2.5$, USS 1558-003 proto-cluster. A positive correlation between SFR and stellar mass in star-forming galaxies is called the main sequence of star-forming galaxies. The well-known tight correlation provides us with perspectives of how the star-forming galaxies evolve over cosmic time. We find that while the star-forming galaxies with $> 10^{9.3}\,M_\odot$ are located on the universal SFR-mass main sequence irrespective of the environment, less massive star-forming galaxies with $< 10^{9.3}\,M_\odot$ show a significant upward scatter from the main sequence in this proto-cluster (see Figure 1). We here summarize the results. Please refer to [1] for more details.

This study is based on a 9.7-hour narrow-band imaging data with MOIRCS on the Subaru telescope. Thanks to the very deep narrow-band data, we are able to construct a sample, in combination with additional *H*-band data taken with WFC3 on Hubble Space Telescope (HST), of 100 HAEs reaching the dust-corrected SFRs down to $3\,M_\odot\,yr^{-1}$ and the stellar masses down to $10^{8.0}\,M_\odot$, allowing us to access less massive galaxies in the proto-cluster. Our results suggest that while the majority of massive galaxies are already settled in a secular evolution phase and are thus found on the main sequence, some less massive galaxies are in a starburst phase and they are significantly up-scattered from the main sequence. This may be consistent with the down-sizing scenario of mass-dependent galaxy evolution, or since they are located in a dense proto-cluster, they may be experiencing some influences from the surrounding environment such as galaxy-galaxy interactions.

The existence of the less massive HAEs with $< 10^{9.3}\,M_\odot$ up-scattered above the main sequence may imply that a scatter around the main sequence increases at lower stellar masses. Diversity of star-formation history in early phase of galaxy evolution and/or sensitivity to the fluctuation of starburst activity at short time scales in individual H_{II} regions could cause the increased scatter.

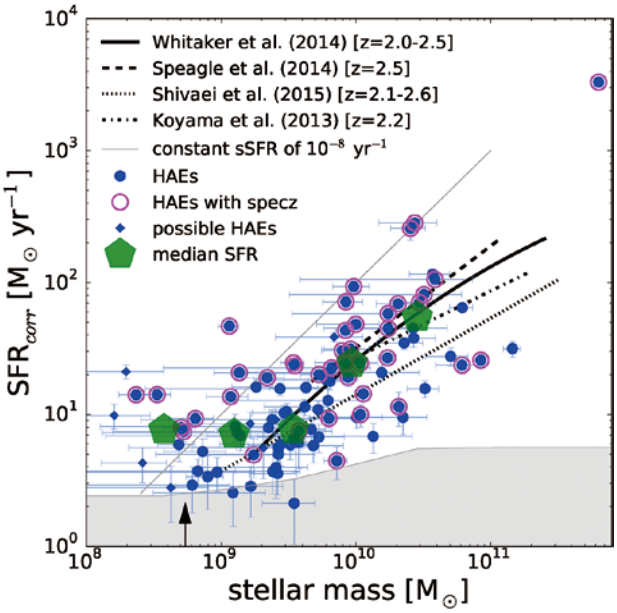

Figure 1: Main sequence of HAEs in the USS1558-003 proto-cluster at $z = 2.53$. The blue-filled circles represent the probable member HAEs at $z \approx 2.53$, while blue-filled diamonds represent the possible HAEs. The HAEs spectroscopically confirmed are marked with magenta open circles. The error bars are derived from the 1σ photometric error. The uncertainties of stellar masses derived from the SED fitting are estimated from a standard deviation of 100 iterations. Pentagons show the median SFRs in each mass bin. The gray region shows the SFRs under the limit reachable. The curves are main sequences from the literature [2,3,4,5]. A gray line shows a constant specific SFR of $10^{-8}\,yr^{-1}$, and an arrow roughly shows the stellar mass limit which is estimated with the 3σ limiting magnitude in K_s and J–K_s color of 0.36.

References

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