Environmental effects on the star formation activity in galaxies at z~1.2

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Abstract

It is widely recognized that the space density of star-formation rate (SFR) dropped dramatically from z=1 to the present. While the understandings of the cosmic star-formation history have significantly improved in the past decade, the cause of this global decline is still unclear. However, it is expected that the decline in the global SFR should be closely linked to the environment, regarding the environmental dependence of galaxy properties at z=0. We therefore focus on the environmental effects on the star formation activity in galaxies, especially at z~1.2. We find that the fraction of (OIII) emitters appears to be almost constant over the local galaxy density. This trend is different from that seen in the local universe, where the star formation activity is weaker in higher density regions. To understand what triggered this difference between z~1 and z~0, we investigate the specific star-formation rate (sSFR) as a function of the local galaxy density. In order to test the selection effects on the results, we use both i'-selected sample and rest-frame K-selected sample. These samples roughly correspond to a SFR-selected and a mass-selected sample, respectively. We find that the sSFR is almost constant at any local galaxy density in both the two samples. This trend is also different from that seen at z~0, where the sSFR decreases with increasing galaxy density.

1. Introduction

To understand the formation and evolution of galaxies

⇒ to know "when" and "where" stars formed in the history of the universe

The current picture of star formation history (SFH)

\[
\begin{array}{c|c}
\text{Star formation rate density} & \text{z}\rightarrow 0 \\
\hline
\text{z=3} & \text{increases with decreasing z} \\
\text{z=2} & \text{decreases with decreasing z} \quad \text{z=1} \\
\text{z=0} & \text{decreases with decreasing z} \\
\end{array}
\]

⇒ While the understandings of the SFH have significantly improved in the past decade, the cause of the global decline from z=1 to z=0 is still unclear.

⇒ It is expected that the decline in the global star-formation rate should be closely linked to the environment regarding the environmental dependence of galaxy properties at z=0.

⇒ It is essential to study the star formation in galaxies as a function of both the redshift (when) and the environment (where).

We study the relation between the [OIII] emitter fraction and the environment in the COSMOS field, especially at z=1 where the SFH indicates rapid evolution.

⇒ We find that the star formation is active in high-density regions at z~1, suggesting a different trend from the tendency observed at z~0.

Environmental dependence of the star formation activity - z~0 vs. z~1

2. Sample

[OIII] emitter sample (z=1.17-1.20)

\[
\begin{array}{c|c|c}
\text{i'-selected NB816} & \text{z< 1.17} & \text{z > 1.17} \\
\hline
\text{NB816-excess objects} & 926 & 1354 \\
\text{z< 1.17} & 896 & 1288 \\
\text{z > 1.17} & 30 & 66 \\
\end{array}
\]

⇒ In order to test selection effects on the results, we use both i'-selected (~SFR limited) and K-selected (~Mass limited) sample.

⇒ We limit two samples only in galaxies with i'<24 and K<22 because the estimated photo-z error is σz=0.02 with i'<24 and K<22.

\[
\begin{array}{c|c|c}
\text{i'-selected sample} & \text{K-selected sample} & \text{i'-selected sample} \\
\hline
\text{Total} & 1654 & 1646 \\
\text{[OIII] emitter} & 132 & 131 \\
\text{Non-[OIII] emitter} & 1522 & 1515 \\
\end{array}
\]

3. Local galaxy density

We estimate the local galaxy density (Σ) by using the distance to the 3rd nearest neighbor from each object (r3 nearest):

\[
\Sigma = \frac{4}{n} \left( \frac{1}{r_{3 \text{ nearest}}} \right) \left( \text{Mpc}^{-3} \right)
\]

4. Specific star formation rate estimate

Stellar Mass (M*)

Estimated by using SED template fitting (We used 30-band including IRAC data)


Universal IMF from Chabrier (2003)

SF activity is expressed by

Local galaxy density

We find that sSFR-density relation at z~1.2 is almost constant at any galaxy density for both the two samples.

Star formation rate (SFR)

Estimated by using the relation

\[
SFR(M_{\odot}/yr) = 1 \times 10^{-1} L([OII]) \quad \text{(ergs}^{-1})
\]

(Kennicutt 1998)

[OII] luminosity is measured by using the flux densities in NB and i' filters.

\[
L([OII]) = 4 \times 10^{10} \text{ergs s}^{-1} \text{M}^{-1}
\]

Specific star formation rate (sSFR)

Calculated by combining the SFR and M*, estimated above

\[
sSFR = \frac{SFR}{M_{\odot}/yr}
\]

5. Results and Discussion

sSFR-density relation @ z~1.2

Evolution of the environmental effects on the sSFR

The environmental dependence of the averaged sSFR appears to build between z=1 and z=0.

6. Summary

⇒ We find that the averaged sSFR in galaxies does not depend on the environment at z~1.2. This trend is different from that seen at z~0 where the sSFR decreases with increasing galaxy density.

⇒ We expect following two scenarios: 1) The time evolution of sSFR is originally different between high-density and low-density environment 2) The environmental effects which strangle star-formation in galaxies occur in high-density regions.