Star-forming activity and interstellar medium conditions of [OIII]-selected galaxies at $z \sim 3.2$

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1. Introduction

In this study, we focus on the epoch of $z = 3$–3.6, which corresponds to 1–2 Gyr before the highest peak of the cosmic star formation rate (SFR) density (e.g. Madau & Dickinson 2014). By investigating star-forming galaxies at $z = 3$–3.6 and comparing them with those at the peak epoch ($z \sim 2$), we aim to understand how physical quantities of galaxies evolve towards the peak.

We need a sample of star-forming galaxies at $z > 3$ with little bias, and we try to use the [OIII]λ5007 emission line. Since star-forming galaxies at higher redshifts tend to show strong [OIII] emission line (e.g. Steidel et al. 2014), and also it is less sensitive to dust extinction than the UV light, we expect that [OIII] can be a useful tracer of star-forming galaxies at high redshifts, especially at $z > 3$, where Hα is no longer accessible from the ground.

In this study, we use a sample of the NB-selected [OIII] emission line galaxies at $z \sim 3.24$ obtained by HiZELS (the High-z Emission Line Survey; e.g. Sobral et al. 2013) and investigate their star-forming activity. Moreover, we carried out near-infrared spectroscopy of ten [OIII] emitters with Keck/MOSFIRE so that we can investigate their interstellar medium (ISM) conditions.

2. Results

Figure 1 shows the relation between the stellar mass and SFR_{UV} of the [OIII] emitters at $z \sim 3.24$ together with the [OIII] emitters at $z \sim 2.23$ in the same field from HiZELS. We find that the [OIII] emitters at $z \sim 3.24$ show similar SFRs as those of the [OIII] emitters at $z \sim 2.23$ at a fixed stellar mass. While the normalization of the stellar mass–SFR relation is almost consistent, the distribution along the relation seems to be different as shown in the top and right panels of Figure 1. The [OIII] emitters at $z \sim 3.24$ show an offset towards the lower stellar mass range, indicating the evolution of galaxies between the two epochs.

Figure 2 shows the relation between the stellar mass and gas metallicity of our spectroscopically confirmed galaxies at $z \sim 3.2$. We introduce some previous studies at $z \sim 2$ (Zahid et al. 2013; Cullen et al. 14; Steidel et al. 2014; Sanders et al. 2015). Gas metallicities of our sample and Cullen et al. (2014) sample are estimated using the formula given by Kobulnicky & Kewley (2004; KK04). As for other samples, we make a correction so that their gas metallicities correspond to those estimated with the KK04 method. Comparing with Cullen et al. (2014) sample, we find that the gas metallicities of our sample at $z \sim 3.2$ are similar as those of star-forming galaxies at $z \sim 2$ at a fixed stellar mass.

Figure 1 and 2 suggest that star-forming activity and ISM conditions of star-forming galaxies do not evolve from $z \sim 3.2$ to $z \sim 2$ at a fixed stellar mass. The properties of star-forming galaxies at $z \sim 2$–3.2 might be primarily determined by their stellar masses rather than redshift. On the other hand, as suggested from an offset of the stellar mass distribution in Figure 1, individual galaxies would experience a significant stellar mass growth between from $z \sim 3.2$ to $z \sim 2$.

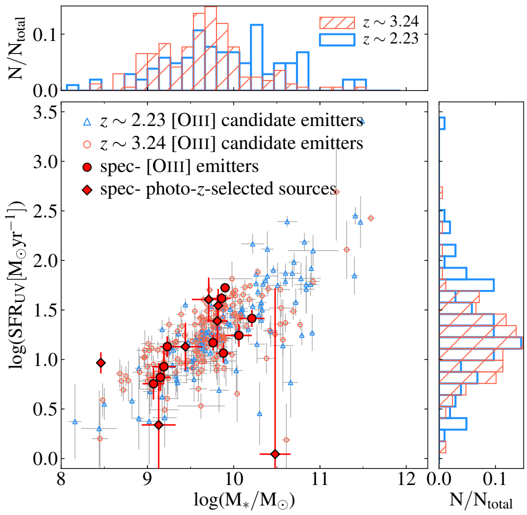

Figure 1: Relation between stellar mass and SFR_{UV}. The [OIII] emitters at $z \sim 3.24$ and $z \sim 2.23$ are shown. The spectroscopically confirmed galaxies are identified. Top and right histogram shows the stellar mass and SFR_{UV} distribution, respectively.

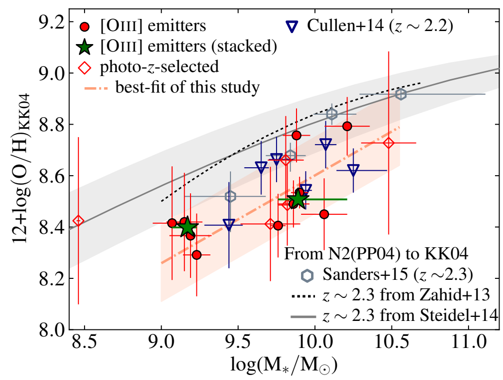

Figure 2: Relation between stellar mass and gas metallicity for our sample at $z \sim 3.2$. We compare our sample with previous studies at $z \sim 2$. The red and gray shaded region corresponds to $\pm 1\sigma$ errors of the best-fitted relation of our sample and Steidel et al. (2014), respectively.

References ○ Cullen et al. 2014, MNRAS, 440, 2300 ○ Kobulnicky & Kewley 2004, ApJ, 617, 240 ○ Madau & Dickinson 2014, ARA&A, 52, 415 ○ Sanders et al. 2015, ApJ, 799, 138 ○ Sobral et al. 2013, MNRAS, 428, 1128 ○ Steidel et al. 2014, ApJ, 795, 165 ○ Zahid et al. 2013, ApJL, 771, L19