Calibrating [OII] Star-formation Rates at $z > 1$ from Dual Hα-[OII] Imaging from HiZELS

HAYASHI, Masao, KODAMA, Tadayuki
(NAOJ)

SOBRAL, David
(Leiden University)

BEST, N., Philip
(Royal Observatory of Edinburgh)

SMAIL, Ian
(Durham University)

Star formation rate (SFR) is one of the most important properties to characterize the growth of a galaxy. The luminosities of emission lines such as Hα (λ6563) and [O II] (λ3727) are widely used as an indicator to derive the star formation activity of galaxies not only in the local Universe but also at high redshifts. However, the Hα line, one of the best indicator well calibrated with the data in the local Universe, is redshifted into near-IR wavelengths for galaxies at $z > 0.4$, while the [O II] line can be observed with an optical instrument until $z \sim 1.7$, and thus many studies/surveys of star-forming galaxies at $z > 0.4$ rely on [O II] luminosity. Moreover, while [O II] luminosity is in general correlated with the star formation activity, it also depends on the metal abundance and the ionization state of nebular gas. The indirect relation with the star formation activity complicates the estimation of SFR from [O II] luminosity. Thus, it is important to make sure whether the ratio of [O II] to Hα luminosities known in local star-forming galaxies is valid for high-z galaxies as well by directly studying earlier epochs in the Universe.

In this study, we investigate the mean relation between Hα and [O II] luminosities for [O II] emitters at $z = 1.47$ in the two fields, UDS and COSMOS, using a stacking analysis which enables us to examine the Hα luminosity of galaxies at $z = 1.47$ even if the individual galaxies are too faint to detect both Hα and [O II] emission lines simultaneously. The main results we have found are summarized below (see also our paper [1] for more details).

We find that on average there is positive correlation between Hα and [O II] luminosities for not only bright galaxies but also faint ones with [O II] luminosity down to 10^{41} erg s^{-1}, i.e, SFR=1.4 M$_\odot$ yr−1. The trend that galaxies with higher [O II] luminosities have higher Hα luminosities is consistent with that of the local galaxies, suggesting that [O II] luminosities can be used as an indicator of SFR even at the high redshift of $z = 1.47$.

However, we have to use the [O II] luminosities with caution to estimate SFRs at $z = 1.47$ based on the relation calibrated with local galaxies. This is because [O II]emitters at $z = 1.47$ show the observed Hα/[O II] line ratios corresponding to $A_{H\alpha} \sim 0.35$ and are less subject to dust attenuation than the local galaxies selected based on [O II] luminosity (Figure 1). Therefore, [O II]-selected emitters at $z = 1.47$ are likely to be biased toward less dusty populations.

On the other hand, we note a caveat to our interpretation of the results in terms of dust extinction only, because the Hα/[O II] line ratio is also dependent on the metallicity. Hence the discrepancy of the line ratio between [O II] emitters at $z = 1.47$ and local galaxies at $z \sim 0.1$ may be explained in terms of metallicity difference. Therefore, the possibility that the low Hα/[O II] ratio is not only due to the lower dust extinction, but also the lower metallicities of [O II] emitters at $z = 1.47$ than local galaxies, cannot be completely ruled out. To distinguish the two factors of dust extinction and metallicity completely, we require deep spectroscopy to obtain the nebular emissions from the individual or stacked spectra.

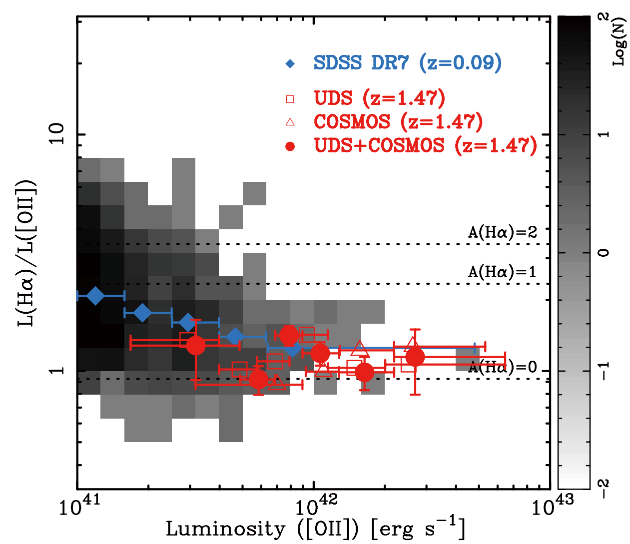

Figure 1: The ratios of Hα to [O II] for [O II] emitters at z = 1.47 are shown by red symbols as a function of [O II] luminosity. The grey-scale map shows the distribution of SDSS galaxies at z = 0.07–0.1, and the blue filled circles represent median Hα/[O II] ratios for the local galaxies in each [O II] luminosity bin. The dotted lines show the ratio of Hα to [O II] in the case of each dust attenuation in Hα ($A_{H\alpha}$).

Reference

[1] Hayashi, M., et al.: 2013, *MNRAS*, **430**, 1042.