Cosmic Star Formation Activity at $z = 2.2$ Probed by Hα Emission Line Galaxies

TADAKI, Ken-ichi (University of Tokyo)
KODAMA, Tadayuki, HAYASHI, Masao (NAOJ)
KOYAMA, Yusei (University of Tokyo)
TANAKA, Ichi (NAOJ)
TOKOKU, Chihiro (Tohoku University)

Since recent observations in optical and near-infrared wavelength indicate that the volume-averaged star formation rate (SFR) increases from $z = 0$ to $z \sim 1$ and plateaus at $z \sim 2$, it is likely that a large fraction of stars in galaxies at present-day formed at $z > 1$. The AGN activity and the redshift distribution of submm galaxies (SMG) also peak at this epoch. Therefore the redshift range of $z = 2$–3 is the epoch when galaxies have the most intensive evolution. It is absolutely imperative to build a statistical sample of star forming galaxies at $z = 2$–3 in order to understand the cosmic star formation history and the early evolution of galaxies.

Taking the advantage that Hα line at $z = 2.19$ is free from any strong OH sky emission line, we have made a custom-made narrow-band filter, namely, NB209 filter. This narrow-band filter captures Hα emission from the galaxies at $z = 2.19 \pm 0.02$. The imaging survey has been carried out with MOIRCS on the Subaru telescope with the NB209 filter in GOODS-N field. The survey reached a 3σ limiting magnitude of 23.6 (NB209) which corresponds to a 3σ limiting line flux of 2.5×10^{-17} erg s^{-1} cm^{-2} over a 56 arcmnin^2 contiguous area. Also, we used the MORICS Deep Survey (MODS) photometric catalog[1], which contains optical ($UBVi'z'$, near-infrared (JHK_s), mid-infrared and X-ray data. Using these dataset, we have identified 12 Hα emitters at $z = 2.2$ on the basis of narrow-band excesses and photometric redshifts. One of them is likely to be a AGN because a Xray emission is detected from this object. For the seven new emitters out of 12, including the AGN candidate, we obtained near-infrared spectra with MOIRCS on multiobject spectroscopy (MOS) mode. Because an emission line, whose flux is above 3σ, is detected from all of them, it is confirmed that our criteria is effective and robust in selecting genuine Hα emitters at $z = 2.2$.

The Hα line, a hydrogen's Balmer series line emitted from ionized gas (i.e., HII region) around hot young stars, is one of the best SFR indicators. It has many great advantages; being less affected by dust extinction, providing a survey with high sensitivity, and having been well calibrated in the local Universe. We have estimated star formation rates (SFR) and stellar masses ($M_{\rm star}$) for individual galaxies from Hα flux and K_s-band magnitude. The average SFR and $M_{\rm star}$ is 27.8 $M_\odot$ yr^{-1} and 4.0×10^{10} $M_\odot$, respectively.

The evolution of galaxies depends strongly on the environment. Because field galaxies are antithetical to cluster galaxies in terms of environment, we can directly examine the environmental dependence of star formation activity by comparing the properties of emitters among different environments. In addition to the present general field survey, we have estimated SFRs and stellar masses for a large sample of star forming galaxies both in clusters and in the other general field at various redshifts. Figure 1 indicates that the evolution of star formation activities both in the fields and in the clusters. We find that the star formation activity is reduced rapidly from $z = 2.5$ to $z = 0.8$ in the cluster environment, while it is only moderately changed in the field environment. This result suggests that the timescale of galaxy formation is different among different environments, and the star forming activities in high density regions eventually overtake those in lower density regions as a consequence of "galaxy formation bias" at high redshifts.

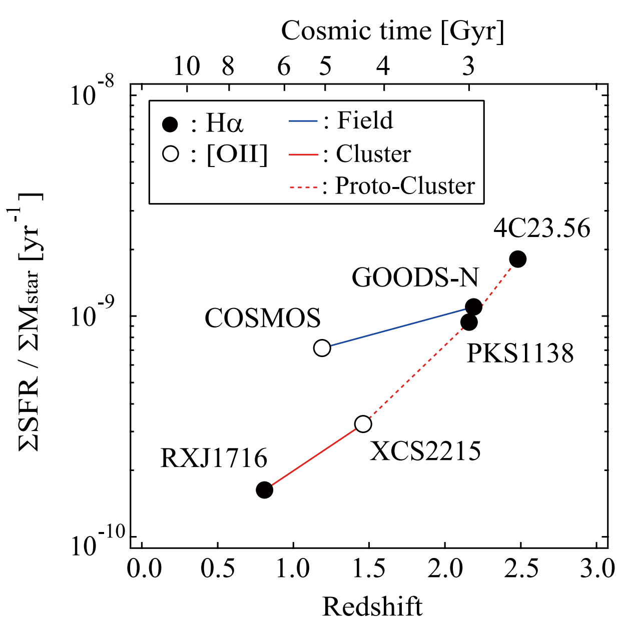

Figure 1: The evolution of star formation activities of the line emitting galaxies. Filled circles and open circles indicate Hα emitters and [OII] emitters, respectively.

Reference

[1] Kajisawa, M., et al.: 2011, *PASJ*, **63S**, 379.