MOIRCS Narrow-Band Survey for Distant Clusters of Galaxies

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It is well established that properties of galaxies, such as colors and morphologies, are strongly correlated with environment where they reside. For example, high-density regions such as clusters of galaxies are filled with ellipticals or lenticulars(S0s), with little on-going star-formation activity[1]. However, it is still unclear when and how this strong environmental dependence is established. To understand what happens on galaxies during the hierarchical assembly in the past Universe, studying distant clusters of galaxies is critically important since they are in the younger stages of the present-day clusters.

Targeting the large-scale structure around a distant galaxy cluster, RXJ1716+6708 at $z = 0.81$ (hereafter RXJ1716), identified in our previous study[2], we performed a wide-field Hα emitter survey for this field using a narrow-band filter (NB119; $\lambda_c = 1.19\,\mu$m) installed on MOIRCS/Subaru, which perfectly matches to the Hα line at $z = 0.81$. The Hα line ($\lambda_{\rm rest}$ = 6563 Å) is one of the best indicators of star formation activity in galaxies. However, it shifts to near-infrared regime at $z > 0.4$, so that it has been quite difficult to conduct an intensive Hα-based study for the distant Universe. We note that this study is the first wide-field Hα line survey for distant ($z > 0.5$) clusters, and revealed the Hα-based star forming activity along the filamentary large-scale structures for the first time.

Our survey shows that the Hα emitters are distributed clearly along the large-scale structure (Fig. 1). On the other hand, we also find that the Hα emitters avoid the very central cluster region. This suggests that the star forming activity in the cluster core has already been completely quenched at $z \sim 0.8$, while in the cluster surrounding region, a large fraction of galaxies are still actively forming stars. This result is also consistent with that obtained through our wide-field 15 μm imaging campaign[3] with AKARI (see red circles in Fig. 1).

We measured star formation rates (SFR) independently from the Hα and mid-infrared (rest-frame 8 μm) luminosities, and find that the extinction at Hα is ~1 mag for moderately star forming galaxies, which is consistent with local spirals. However, in the extremely dusty cases, this value exceeds ~3 mag. These very dusty galaxies show red colors, and some of them are on the red sequence whose colors are consistent with those expected for "non-star-forming" galaxies. More impor-tantly, we find that such very dusty galaxies (probably in the transitional phase under some environmental effects) are most commonly seen in the cluster surrounding groups or filaments, strongly supporting the importance of the cluster surrounding environment as a key place for shaping the environmentally-driven galaxy evolution. Thus, taking a great advantage of the widefield capability of Subaru Telescope, we revealed the evidence that the dust-obscured activities of galaxies (dusty starbursts and/or AGNs) are indeed taking place in the cluster in-fall regions, suggesting a strong link between these hidden activity and environmental effects.

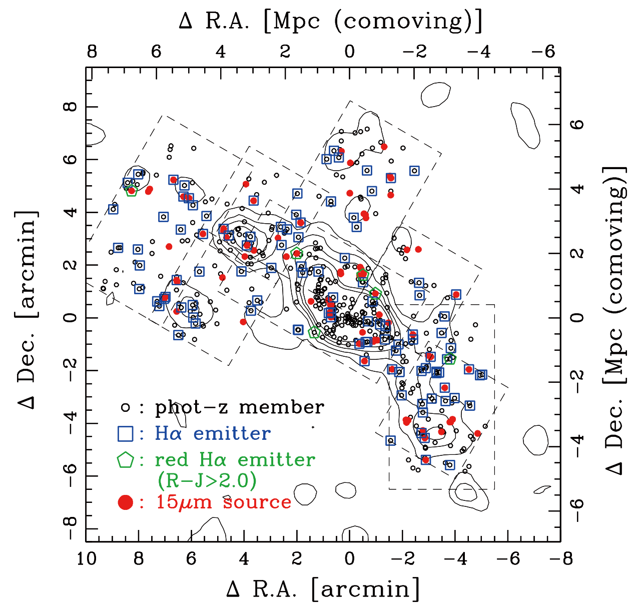

Figure 1: Spatial distribution of the cluster member galaxies around the RXJ1716 cluster at $z = 0.81$. The dashed-line rectangles show our 8 FoVs of MOIRCS. Black dots represent all the phot-z selected galaxies within our observed field. Blue squares, green pentagons, and filled red circles indicate the Hα emitters, the red Hα emitters, and the mid-infrared sources detected in our AKARI 15 μm imaging. Contours are drawn based on surface number density of cluster member galaxies.

References

[1] Dressler, A.: 1980, *ApJ*, **236**, 351.
[2] Koyama, Y., et al.: 2007, *MNRAS*, **382**, 1719.
[3] Koyama, Y., et al.: 2008, *MNRAS*, **391**, 1758.