論文の内容の要旨

Diffuse Hydrogen Lyman Alpha Emission Around Star-Forming Galaxies at High Redshift Probed by Optical Imaging and Spectroscopy

(可視光撮像と分光で探る高赤方偏移の
星形成銀河周辺に存在する淡い水素ライマンアルファ輝線)

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We study the spatially extended hydrogen Lyα emission around Lyα blobs (LABs), which are star-forming galaxies with bright (Lyα luminosity $L_{\mathrm{Ly}\alpha} \gtrsim 10^{43.4}$ erg s^{-1}) and extended Lyα emission, at $z = 4.9 - 7.0$. With the Subaru Hyper Suprime-Cam (HSC), we have carried out a deep and wide-field imaging survey. Using the imaging data obtained from our survey, we have identified two new LABs dubbed z70-1 and z49-1 at $z = 6.965$ and $z = 4.888$, respectively. We present the photometric and spectroscopic properties of a total of seven LABs; the two new LABs and five previously known LABs at $z = 5.7 - 6.6$. The z70-1 LAB (Figure 1) shows the extended Lyα emission with a scale length of 1.4 ± 0.2 kpc, about three times larger than the UV continuum emission, making z70-1 the most distant LAB identified to date. All of the 7 LABs, except z49-1, exhibit no AGN signatures such as X-ray emission, N$\textsc{v}\lambda$1240 emission, or Lyα line broadening, while z49-1 has a strong C$\textsc{iv}\lambda$1548 emission line possibly indicating an AGN on the basis of the UV-line ratio diagnostics. In the small scale of 5 kpc on the spectra, our LABs show Lyα velocity and line-width gradients that may be caused by dynamical systems (e.g. mergers) or a surrounding

cloud of thick HI gas with varying column densities. We investigate the large-scale structure around our LABs by calculating the LAE overdensity, and show that all of the 7 LABs are located in overdense regions. With SED fitting, we show that the LABs have a variety of specific SFRs suggesting the existence of star-burst and non-star-burst phases in LABs.

We carefully extract the Lyα profiles of our LABs after homogenizing the point-spread functions of the HSC images, and conduct two-component exponential profile fitting to the extended Lyα emission of the LABs. The Lyα scale lengths of the core (star-forming region) and the halo components are $r_{\rm c} = 0.6 - 1.2$ kpc and $r_{\rm h} = 2.0 - 13.8$ kpc, respectively. We show that the relations between the scale lengths and galaxy properties (Lyα luminosity $L_{\rm Ly\alpha}$; Figure 2, Lyα rest-frame equivalent width $\rm EW_0$, and UV continuum magnitude $M_{\rm UV}$) of our LABs are similar to those of Lyα halos (LAHs) identified around star-forming galaxies found previously by VLT/MUSE at the similar redshifts. We find no strong evidence supporting that our LABs and previously known LAHs are distinct populations.

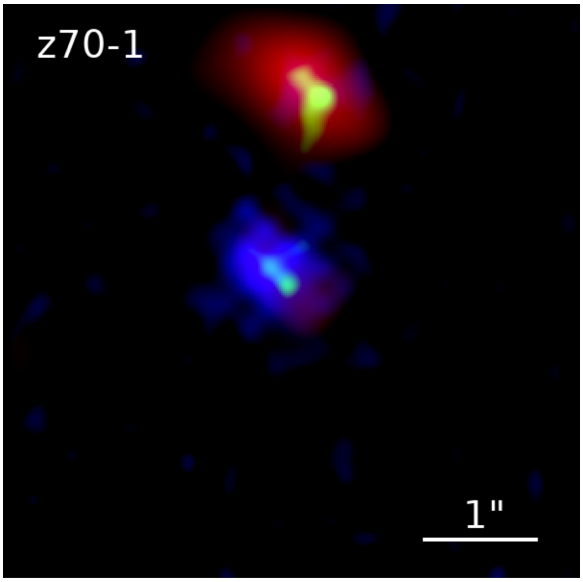

Figure 1 Composite pseudocolor image of z70-1. The upper object is a foreground source. The red, green, and blue (RGB) colors are presented with 3.6 μm (infrared continuum), y (ultraviolet continuum), and NB973 (Lyα) images, respectively. The size of the images is $5'' \times 5''$. The length of $1''$ is indicated as a white bar.

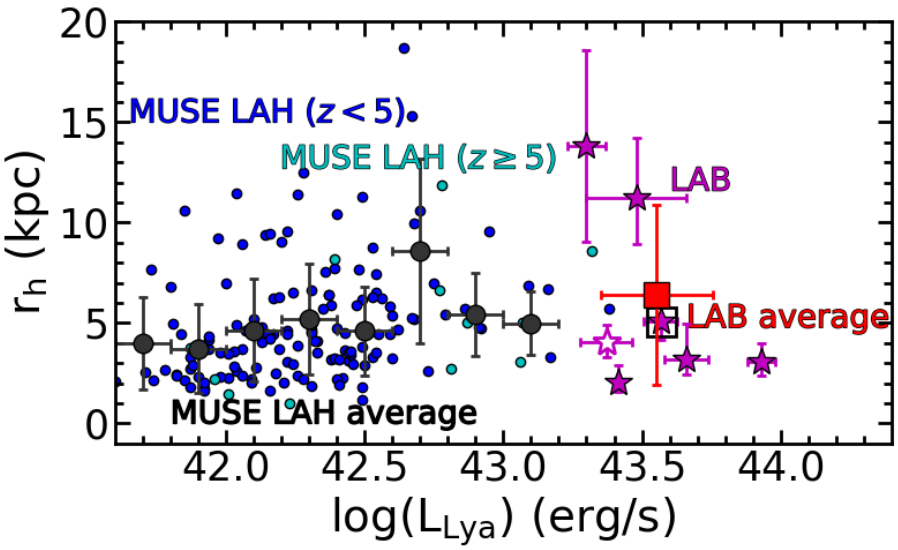

Figure 2 Halo scale length as a function of Lyα luminosity of the 7 LABs (stars) and MUSE LAHs (filled circles) from Leclercq et al. (2017). The empty star represents a LAB z57-2 at $z = 5.7$ that does not have a two-component fitting result. The red filled square shows the average value of our LABs, with error bars indicating the root mean squares. The MUSE LAHs at $z < 5$ and $z \geq 5$ are blue and cyan filled circles, respectively. The average values of MUSE LAHs are shown as black filled circles. The black horizontal error bar indicates the bin size, while the black vertical error bar is the root mean square. In the top panel, we slightly shift z49-1 (boxed star) along the horizontal axis by +0.03 to avoid overlaps.