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The environment of large equivalent width Lyα emitters at $z \sim 3$

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Abstract. We present the environmental properties of a sample of 260 Lyα emitters (LAEs) with extremely large equivalent widths (EW_0 >240 Å) at $z \sim 3$. Such large EW LAEs may be very low-metal / young starbursts in void regions or HI gas / galaxies illuminated by ionizing radiation from the QSO. We undertook Subaru/HSC Lyα imaging observations around a hyper luminous QSO at $z = 2.84$. We identified 3490 LAEs including 260 large EW LAEs. We found that the large EW LAEs tend to lie at galaxy over-dense regions surrounding the QSO, suggesting that most of the large EW LAEs are illuminated by the QSO. From the radial distribution of the large EW LAEs from the QSO, we found that the fraction of large EW LAE shows two excesses in the range of 2 to 5 Mpc and 14 to 16 Mpc from the QSO. If the two peaks are reflected with the QSO activity, the QSO should have episodic lifetimes with ∼10 Myr duration and ∼30 Myr separations. However, we require future spectroscopic observations to investigate if the large EW LAEs far from the QSO are low-metal young starbursts.

Keywords. Lyα emitters, QSO, Environment

1. Introduction

The accretion disk created when gas or dust falls into the black hole is shining. It is a very compact and heavily time varying object. QSO lifetime is generally said to be 1 Myr to 100 Myr (Martini 2004), but we do not know what kind of activities have occurred among them. In this time, we thought about triggers of the QSO activity by investigating the QSO activity. The equivalent width (EW) of emission line shows the line strength relative to the continuum. Lyα emitters (LAEs) with extremely large EW (EW_0 >240 Å) are thought to be good analogues of the PopIII galaxies or first galaxies, because such large EW could only be produced from star formation with very low metallicity or in a short period (Schaerer 2002). Theoretical works predict that such galaxies could remain in un-evolved region (i.e., void regions) even at $z \sim 3$ (Tornatore *et al.* 2007). An alternative case is HI gas / galaxy illuminated by ionizing radiation from the QSO (Cantalupo *et al.* 2012). In this case, the large EW LAEs should distribute in the vicinity of the QSOs, which are likely to be formed at the peak of over-dense regions.

2. Data and LAE Selection

We undertook deep, wide-field Lyα imaging observations around a hyper luminous QSO at $z = 2.843$ (HS1549+1919, Trainor & Steidel 2013) by using a custom narrow-band filter, NB468, on Subaru/HSC. We obtained 2.2 hours g-band and 6.3 hours

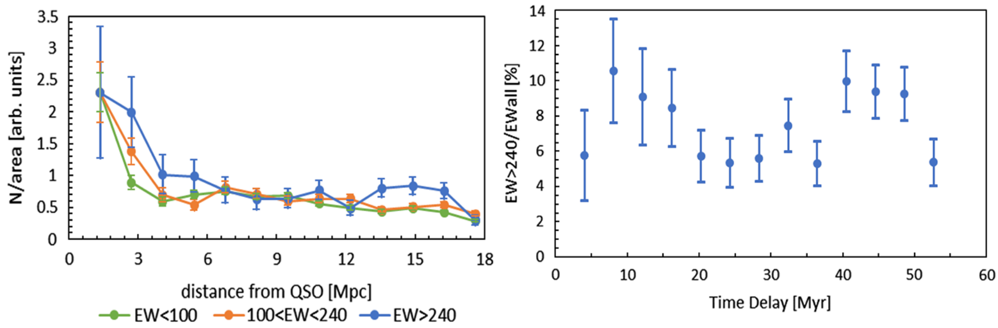

Figure 1. (Left) Comparison of surface densities of LAEs with EW_0<100 Å (green), 100 Å <EW_0<240 Å (orange), and EW_0>240 Å (blue) as a function of projected distance from the QSO. The surface densities are normalized at the shortest distance (∼1 Mpc). We found that large EW LAEs show excess in the range of 2 to 5 Mpc and 14 to 16 Mpc. **(Right)** Fraction of large EW LAEs over all LAEs as a function of time delay (i.e., light travel time from the QSO). This fraction shows excesses at 10 to 20 Myr and 40 to 50 Myr, suggesting that QSO has episodic lifetimes with ∼10 Myr duration and ∼30 Myr separation.

NB468 data. We identified 3490 LAEs brighter than $NB468 < 26.6$mag and rest-frame EW ($EW_0 \geqslant$12 Å) including 260 large EW LAEs ($EW_0 \geqslant$240 Å) in this field.

3. Results and Discussion

We found that the large EW LAEs tend to lie at over dense regions of normal LAEs, suggesting that the large EW LAEs are HI gas / galaxy illuminated by ionizing radiation from the QSO rather than low metal galaxies in void regions (Figure 1, left). It seems that these two peaks indicate that there is a wave in QSO activity. Furthermore, considering the history of activities based on the distance from QSO, the fraction of large EW LAEs shows excesses at 10 to 20 Myr and 40 to 50 Myr, suggesting that the QSO has episodic lifetimes with ∼10 Myr duration and ∼30 Myr separations (Figure 1, right).

In this work, we investigated the QSO lifetime 11 Gyrs ago with Lyα light echo. Although we found a hint of episodic lifetime, each duration of 10 Myr is consistent with the estimates from the previous studies (1 Myr $\lesssim t_Q \lesssim$ 20 Myr, Trainor & Steidel 2013). We note that the lowest fraction seems to have a constant value around 6% in Figure 1 (right). This is possibly due to the uncertainty of the true distance from the QSO because we used the projected distance assuming the LAEs have the same redshifts. Another issue is that our large EW LAE sample far from the QSO potentially includes young low-metal galaxies in un-evolved regions, because the second excess of large EW LAE at ∼15 Mpc are relatively far from the QSO. Therefore we require future spectroscopic follow-up observations to measure the true 3D distance from the QSO and to search for other emission lines for metallicity measurements.

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