

Photometry and Spectroscopy of *i*-drop Galaxies: Possible Detection of A Proto-cluster at $z = 6^\dagger$

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Abstract. We discovered 30 candidate galaxies are clustering in a small ~ 200 Mpc² region at $z = 6$ with 5σ local density excess in a wide 876 arcmin² field. Four of them were spectroscopically identified as $z = 5.9$ – 6.0 Ly α emitters (~ 34 Mpc in line-of-sight). This structure is comparable to $z = 4.8$ and 5.7 galaxy proto-clusters previously found. Since the other candidates are likely to be real galaxies due to low sample contamination, the overdensity can be a $z \sim 6$ proto-cluster.

Keywords. galaxies: high-redshift, cosmology: observations, large-scale structure of universe

1. $z \sim 6$ *i*-drop Galaxy Sample in the Subaru Deep Field

In the Subaru Deep Field (SDF; $13^h 24^m 21.^s 4$, $-27^\circ 29' 23''$ [J2000], ~ 876 arcmin²), using its $(B, V, i', z') = (28.45, 27.74, 27.43, 26.62)$ (AB mags in 3σ with $2''$ aperture) images, we selected out $z \sim 6$ candidate galaxies by an *i*-drop criterion: $B, V < 3\sigma$, $i' - z' > 1.5$, $z' \leq 26.5$. This captures a sharp continuum break at Ly α (rest frame 1216Å; ~ 8512 Å at $z \sim 6$). Our *i*-drops could be contaminated by M/L/T dwarfs (28.5%), $z \sim 1$ – 2 ellipticals (0%) and $z \sim 6$ quasars (0.13%), estimated using a star count model, an old elliptical sample actually observed in another Subaru deep survey, and a quasar luminosity function (Ota *et al.* 2005). Throughout we adapt a cosmology with $(\Omega_M, \Omega_\Lambda, h) = (0.3, 0.7, 0.7)$.

2. Sky Distribution and Spectroscopy: Discovery of Overdensity

We investigated sky distribution of *i*-drops and local surface overdensity $\delta_\Sigma \equiv (\Sigma(x, y) - \bar{\Sigma})/\bar{\Sigma}$, where $\Sigma(x, y)$ is the number of *i*-drops in a co-moving 8 Mpc circle at $z = 6$, and $\bar{\Sigma}$ is the mean of Σ measured in random $\sim 65,000$ positions in SDF. We found the highest 5σ ($\delta_\Sigma = 4.5$) density excess comprising 30 *i*-drops clustering in ~ 50 arcmin² (~ 200 Mpc² at $z = 6$). We made spectroscopy of some of them with Subaru Faint Object Camera and Spectrograph and found four are Ly α emitters at the close redshifts $z = 5.92, 5.99, 6.00$ and 6.03 , corresponding to co-moving line-of-sight ~ 34 Mpc. This structure is similar to $z \sim 4.8$ and 5.7 galaxy proto-clusters known (Shimasaku *et al.* 2003; Ouchi *et al.* 2005). Since 71.4% of unconfirmed *i*-drops could be $z \sim 6$ galaxies, the overdensity can be a $z \sim 6$ proto-cluster. This implies the cosmic reionization was ongoing spatially inhomogeneously when completing at $z \sim 6$ as Ly α emitters are possible reionizing sources.

[†] Based on data collected at Subaru Telescope, which is operated by the National Astronomical Observatory of Japan.

References

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