

The end of the re-ionization epoch probed by Ly α emitters at $z=6.5$

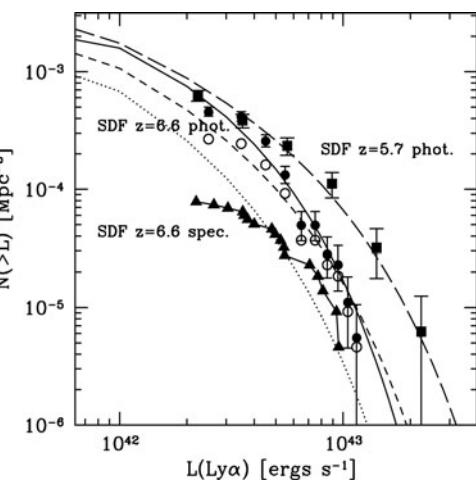
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Abstract. We report an extensive search for Ly α emitters (LAEs) at $z=6.5$ in the Subaru Deep Field (SDF). We carried out spectroscopic observations with Subaru/Keck to identify LAEs at $z=6.5$ that were selected by narrow-band excess at 920 nm. We have identified eight new LAEs based on their significantly asymmetric Ly α emission profiles. This increases the sample of spectroscopically confirmed $z=6.5$ LAEs in the SDF to 17. Based on this spectroscopic sample of 17, complemented by a photometric sample of 58 LAEs, we have derived a more accurate Ly α luminosity function (LF) of LAEs at $z=6.5$, which reveals an apparent deficit at the bright end, of ~ 0.75 mag fainter L^* , compared with that observed at $z=5.7$. The difference has 3σ significance, which is reduced to 2σ when cosmic variance is taken into account. Several LAEs with high Ly α luminosity have been actually identified by spectroscopy at $z < 5.7$, while our LAE sample at $z=6.5$ has no confirmed object having such a high Ly α luminosity. The LF of the rest UV continuum, which is not sensitive to neutral IGM, of our LAE sample has almost the same as those of LAEs at $z=5.7$ and i -dropouts at $z \simeq 6$, even at their bright ends. This result may imply that the reionization of the universe has not been completed at $z=6.5$. The decline of the Ly α LF implies the cosmic neutral fraction $x_{\text{HI}}=0.45$ based on a theoretical IGM model, although this predicted value is strongly model dependent. The spatial distribution of our LAE sample was found to be homogeneous over the field, based on three independent methods to quantify the clustering strength. The composite spectrum of our LAE sample clearly reveals an asymmetric Ly α profile with an extended red wing, which can be explained by either a galactic wind model composed of double Gaussian profiles, or by a reionization model expected from the damping wing profile. Although our result has uncertainties in LAE evolution and large cosmic variance, it can be interpreted that LAEs at $z=6.5$ are at the end of the reionization epoch.

Keywords. cosmology: observations, early universe

Figure 1: Cumulative Ly α LF of our LAE sample at $z=6.5$. The open circles denote the raw counts of our spectroscopic sample + additional photometric sample, and the filled circles are corrected for detection completeness. The triangles denote the raw counts of the pure spectroscopic sample. The squares indicate the LF of LAEs at $z=5.7$ evaluated from the SDF. The short-dashed and dotted lines show the Schechter LFs, in which the Ly α luminosities are reduced by a factor of 0.6 ($L^* \times 0.6$) and 0.4 from the $z=5.7$ LF, respectively.



Reference

Kashikawa, N., Shimasaku, K., Malkan, M. A., et al. 2006, *ApJ*, 648, 7