Completing the Census of Lyα Emitters at the Reionization Epoch

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We carried out extended spectroscopic confirmations of Lyα emitters (LAEs) at z = 6.5 and 5.7 in the Subaru Deep Field. Now, the total number of spectroscopically confirmed LAEs is 45 and 54 at z = 6.5 and 5.7, respectively, and at least 81 % (70 %) of our photometric candidates at z = 6.5 (5.7) have been spectroscopically identified as real LAEs. We made careful measurements of the Lyα luminosity, both photometrically and spectroscopically, to accurately determine the Lyα and rest-UV luminosity functions (LFs), which can constrain the cosmic reionization process. Given the large number of spectroscopic confirmations in our LAE sample, the Lyα LFs at both redshifts are more tightly constrained than those in our previous studies. The substantially improved evaluation of the Lyα LF at z = 6.5 shows an apparent deficit from z = 5.7 at least at the bright end, and a possible decline even at the faint end, though small uncertainties remain. The Lyα LF at z = 6.5 shows a 24 % decrease in the Lyα luminosity, or a 34 % decrease in the LF amplitude. The rest-UV LFs at z = 6.5 and 5.7 are in good agreement, at least at the bright end, in clear contrast to the differences seen in the Lyα LF. These results imply an increase in the neutral fraction of the intergalactic medium from z = 5.7 to 6.5. The rest-frame equivalent width (EW_0) distribution at z = 6.5 seems to be systematically smaller than z = 5.7, and it shows an extended tail toward larger EW_0. The bright end of the rest-UV LF can be reproduced from the observed Lyα LF and a reasonable EW_0–UV luminosity relation. Integrating this rest-UV LF provides the first measurement of the contribution of LAEs to the photon budget required for reionization. The derived UV LF suggests that the fractional contribution of LAEs to the photon budget among Lyman break galaxies significantly increases toward faint magnitudes. Low-luminosity LAEs could dominate the ionizing photon budget, though this inference depends strongly on the uncertain faint-end slope of the Lyα LF [1].

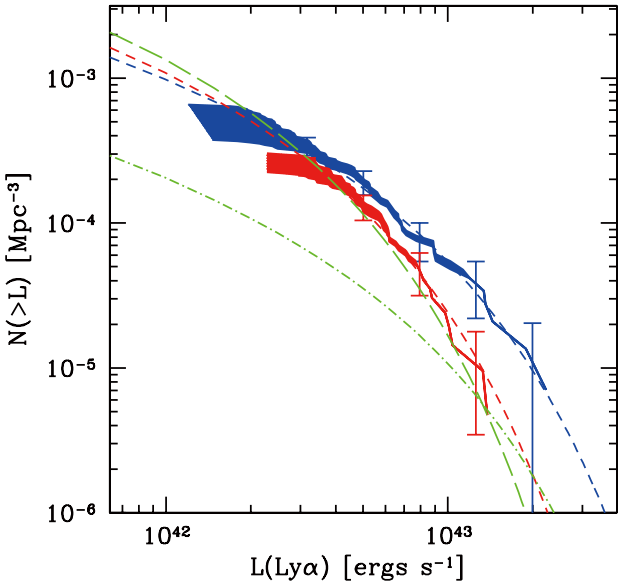

Figure 1: Comparison of the cumulative Lyα LFs of LAEs at z = 6.5 (red-shaded region) and z = 5.7 (blue-shaded region). We estimated the acceptable Lyα LF ranges as specified by the upper and lower limits. The upper limit was estimated assuming that all the uncertain photometric candidates are really LAEs, and the lower limit was estimated assuming that all the uncertain candidates are not LAEs, *i.e.*, using only the pure spectroscopically identified LAE sample. In both the upper and lower limit estimates, we corrected for the detection completeness by number weighting according to the NB magnitude. Error bars evaluated by the Poisson errors are shown in some average data points between the upper limits and lower limits. The short-dashed lines (red for z = 6.5 and blue for z = 5.7) show the fitted Schechter LFs in the case of α = −1.5. As a comparison, the green long-dashed line shows the Lyα LF at z = 6.5 from Ouchi et al. 2010, and the green dot-dashed line shows that of Hu et al. 2010.

Reference

[1] Kashikawa, N., et al.: 2011, *ApJ*, **734**, 119.