On the Role of Galaxies and AGN in Reionizing the IGM: Keck Spectroscopy of z> 5 Galaxies in QSO fields

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Abstract

Study of reionization has now experiencing a surge of new insights, but the long-standing problem 'what reionized the universe?' still remains unsolved. Hubble observations have placed a now-commonly-held view that the intrinsically faint galaxies are responsible for driving the reionization process, but with a fundamental assumption of large escape fractions $> 10\%$. A further puzzle comes from the recent deep spectroscopy of luminous galaxies and the spatial opacity fluctuation of the intergalactic medium (IGM) at z> 5.7, which suggests a possibly important role of luminous systems and active galactic nuclei (AGN). To address these issues, we introduce a new Keck spectroscopic programme surveying z> 5 Lyman-break galaxies (LBGs) around the Lyman alpha forest region of a background QSO to directly examine the spatial correlation between galaxies and physical states of the IGM. By cross-correlating the LBGs with Lyman alpha forest, the data shows a tentative statistical HI proximity effect around LBGs, and by interpreting this as arising from faint galaxies clustered around the LBGs, we derive a constraint on the population-averaged LyC escape fraction $> 8\%$ at z=5.8. We also report evidence of the individual transverse proximity effect around a luminous LBG and broad Lyman alpha transmission spikes around a faint AGN. With a help of cosmological simulations, we discuss the possible origin of such associations which suggest that while faint galaxies are primarily driving reionization, luminous galaxies and AGN may provide an important contribution to the UV background and thermal fluctuations of the IGM towards the end of reionization. Although a limited sample, our results demonstrate the potential of future large spectroscopic galaxy survey in z> 6 QSO fields, allowing us to gain new insights into the reionization era before the arrival of JWST, ELT, and SKA.

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