A large number of $z > 6$ galaxies around a QSO at $z = 6.43$: Evidence for a protocluster?

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QSOs have been thought to be important for tracing highly biased regions in the early universe, from which the present-day massive galaxies and galaxy clusters formed. While overdensities of star-forming galaxies have been found around QSOs at $2 < z < 5$[1,2,3], the case for excess galaxy clustering around QSOs at $z > 6$ is less clear. Previous studies with HST have reported the detection of small excesses of faint dropout galaxies in some QSO fields, but these surveys probed a relatively small region surrounding the QSOs[4]. To overcome this problem, we have observed the most distant QSO at $z = 6.4$ using the large field of view of the Suprime-Cam (34′ × 27′. Newly-installed red-sensitive fully depleted CCDs allowed us to select Lyman break galaxies (LBG) at $z \sim 6.4$ more efficiently. We found seven LBGs in the QSO field, whereas only one exists in a comparison field[5]. The significance of this apparent excess is difficult to quantify without spectroscopic confirmation and additional control fields. The Poisson probability to find seven objects when one expects four is ~10%, while the probability to find seven objects in one field and only one in the other is less than 0.4%, suggesting that the QSO field is significantly overdense relative to the control field. These conclusions are supported by a comparison with a cosmological SPH simulation which includes the higher order clustering of galaxies. We find some evidence that the LBGs are distributed in a ring-like shape centered on the QSO with a radius of ~3 M pc. There are no candidate LBGs within 2 Mpc from the QSO, i.e., galaxies are clustered around the QSO but appear to avoid the very center. These results suggest that the QSO is embedded in an overdense region when defined on a sufficiently large scale (i.e. larger than an HST/ACS pointing). This suggests that the QSO was indeed born in a massive halo. The central deficit of galaxies may indicate that (1) the strong UV radiation from the QSO suppressed galaxy formation in its vicinity, or (2) that star-formation closest to the QSO occurs mostly in an obscured mode that is missed by our UV selection.

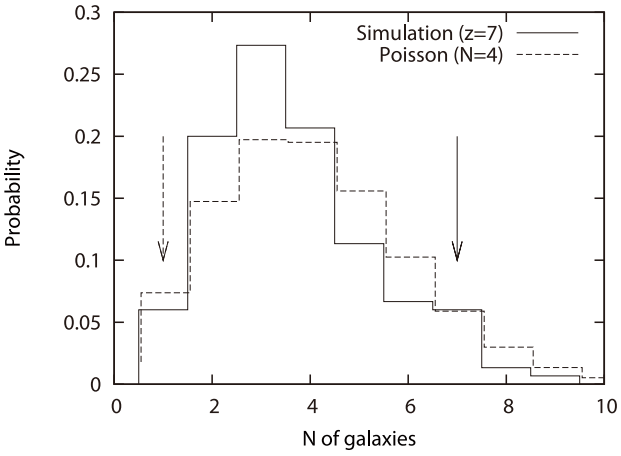

Figure 1: The probability distribution of how many galaxies would be found within the field of view of Suprime-Cam using our selection criteria. The solid histogram is based on the simulation of galaxy formation at $z = 7$ while the dashed histogram is the poisson distribution assuming the average value is $(7 + 1)/2 = 4$. The solid and the dashed arrows indicate the number of galaxies in the QSO field and the SDF comparison field, respectively.

References

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