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CLUSTERING PROPERTIES OF HIGH MATTER DENSITY PEAKS FROM UVES OBSERVATIONS OF QSO PAIRS

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The association of high H I column density absorption systems in QSO spectra with galactic objects has been widely verified at redshifts up to $z \sim 1$, by direct imaging of QSO fields and follow-up spectroscopy (Guillemin & Bergeron 1997; Le Brun et al. 1997). We study the transverse clustering properties of these tracers of high matter density peaks, by looking for coincident absorption systems in adjacent lines of sight toward QSO pairs and groups (D'Odorico et al. 2002).

We obtained high resolution VLT+UVES spectra of two QSO pairs (UM680/UM681 at 56 arcsec angular separation and Q2344+1228/Q2343+1232 at 5 arcmin angular separation) and a QSO triplet (Q2139-4433/Q2139-4434/Q2138-4427 at 1, 7 and 8 arcmin angular separation) at redshifts between 2 and 3. In each spectrum, we searched for the presence of Lyman limit systems (LLS, characterized by $N(\mathrm{H\,I}) \geq 2 \times 10^{17}$ cm^{-2}). When a LLS or a C IV system with rest equivalent width $W_{\mathrm{r}} > 0.5$ Å was seen along the nearby line of sight within ~ 1000 km s^{-1} from the former LLS, we called it a coincidence. We assumed that LLS and C IV absorption systems with $W_{\mathrm{r}} > 0.5$ Å trace the same kind of overdensity, since their observed number densities are similar at the same redshift (Steidel et al. 1988, Steidel 1990).

We detected 3 damped Lyman-α systems (DLAS, ($N(\mathrm{H\,I}) > 2 \times 10^{20}$ cm^{-2}): two coincide with metal systems with C IV rest equivalent width $W_{\mathrm{r}}(\lambda 1548) > 0.5$ Å (see Fig. 1), and one is at less than 1000 km s^{-1} from the emission redshift of the paired QSO, which in turn is marking the presence of a high matter density peak. Of the 7 LLSs we observed: four form two coinciding pairs at $z_{\mathrm{a}} \sim 2.03$ and 2.12 in the spectra of UM680 and UM681, with transverse spatial separations of $\sim 900\ h^{-1}$ kpc. The remaining three have corresponding Lyman-α absorptions in the paired line of sight without associated metals within 3000 km s^{-1}.

In summary, we detect five out of ten matching systems within 1000 km s^{-1}, indicating a highly significant overdensity of strong absorption systems over separation lengths from ~ 1 to 8 h^{-1} Mpc. The gas giving rise to the coincidences close to the emission redshift of the QSOs (in UM680, UM681) could be due to galactic superwind expelled in a luminous starburst associated with the formation of the quasar itself. In the other cases, involving DLASs and separations between ~ 5 and 9 Mpc, the gas could be in coherent filamentary or sheet-like structures of several Mpc, the possible ancestors of present-day rich clusters.

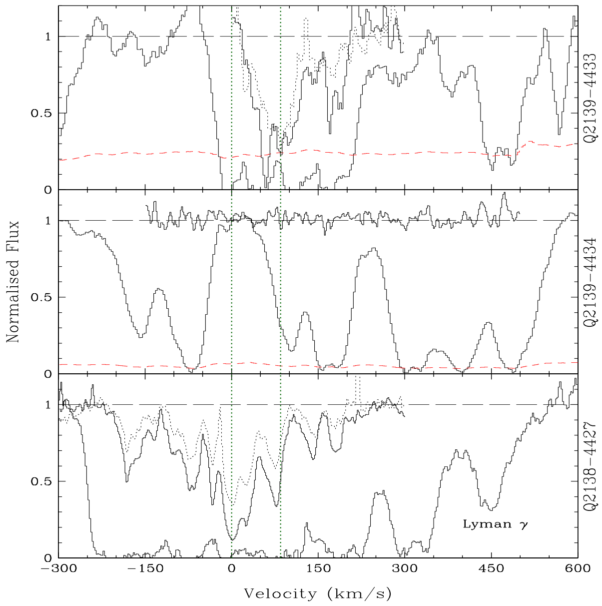

Fig. 1. Coincidence at $z \sim 2.85$. The H I Lyman-α transitions are shown (bottom: H I Lyman-γ of the DLAS) with overplotted the corresponding C IV doublets if present. The transverse spatial separations between the LOSs are ~ 1, 9 and 8 h^{-1} Mpc for the pairs Q2139-4434/Q2139-4433, Q2139-4434/Q2138-4427 and Q2139-4433/Q2138-4427 respectively

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