Overdensities around the most UV luminous QSOs at z=1-2

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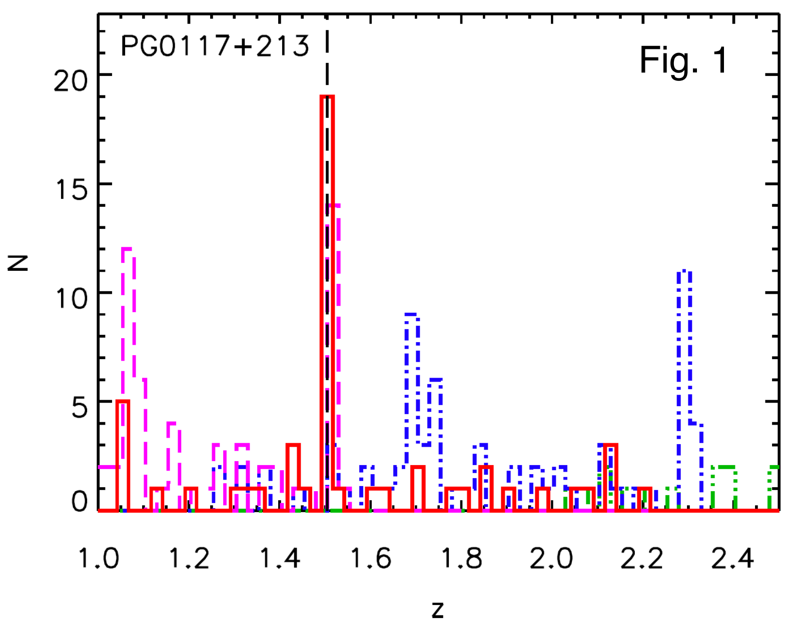
Abstract: We discovered that the majority of the UV brightest QSOs at z=1-2 are located within galaxy overdensities that are comparable to the progenitors of massive nearby clusters. **Of the 12 QSO fields studied, 8 display evidence for a galaxy overdensity** at the redshift of the QSO. One of the overdensities, PG0117+213 at z = 1.50, has potentially 36 spectroscopically confirmed members, consisting of 19 with secure redshifts and 17 with single-line redshifts, within a cylinder of Δz=±0.0125 and radius ~ 700 kpc.

The QSO Sightline and Galaxy Evolution survey (QSAGE, PIs: R. Bielby & J. Stott) is a 96 orbit HST WFC3 grism survey to obtain redshifts along the lines of sight to 12 UV bright QSOs at z=1-2. The primary goal is to study the circumgalactic medium around galaxies at cosmic noon (e.g. Bielby et al., 2019).
However, Fig. 1 shows the redshift distribution of galaxies in the PG0117+213 field. The spike at z=1.50 corresponds to the QSO redshift.



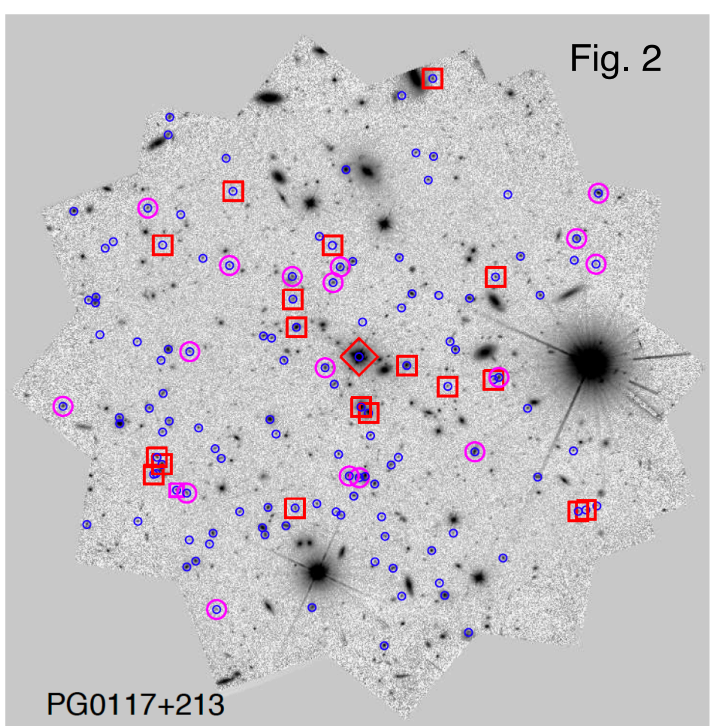
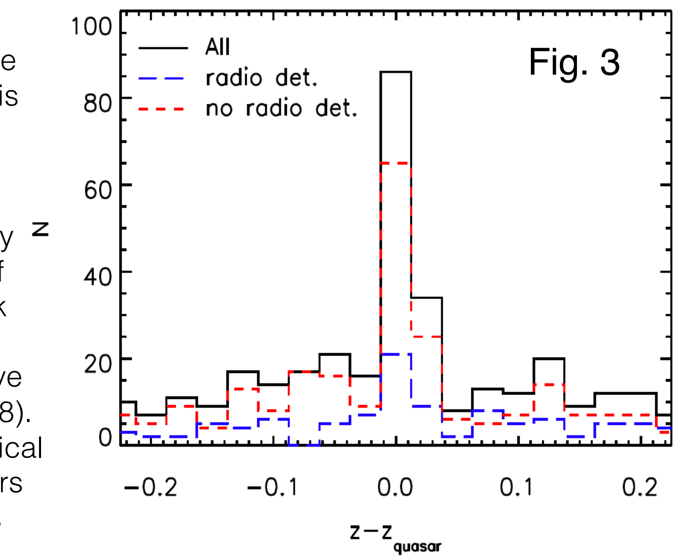


Fig 2. shows the distribution of the overdensity members around the z=1.50 QSO PG0117+213 (central red diamond). To qualify for the overdensity the galaxies have to be with Δz=±0.0125 of the QSO redshift. The red squares are unambiguous members (i.e. spectra with multiple emission lines) and the magenta circles are single line redshifts which, if Halpha, would also be at the cluster redshift, making 36 members in total, all within a radius of 700kpc. If not already virialised then this system will collapse to be a $\log(M/M_{\odot})>14.7$ cluster by z=0. The other overdensities are similarly massive, see Table 1.

Fig. 3 shows a stack of all of the galaxies in the sample relative to the redshift of the QSO in their field. This demonstrates the strength of the connection between the most UV luminous QSOs and overdensities. This has not been seen conclusively before but agrees with the theory of feedback regulated growth of black holes, such that the most luminous QSOs should be in the most massive dark matter halos (Silk & Rees, 1998). It also agrees with hints from statistical studies in which the brighter quasars appear to have higher halo masses (Geach et al. 2019).



field name	N_{clust}	N_{sl}	δ_g	σ_δ	δ_g/σ_δ	Radio	M_B	R.A.	Dec.	$\log(M_{od}/M_{\odot})$
PG0117+213	19	17	17.5	4.8	3.6	n	-28.8	01:20:17.5	+21:33:44.6	14.7±0.5
PKS-0232-04	7	4	6.3	2.9	2.2	y	-28.0	02:35:08.3	-04:01:46.4	14.3±0.4
HE0515-4414	7	1	9.7	4.4	2.2	n	-29.5	05:17:08.8	-44:10:41.6	14.5±0.4
QSO-B0747+4259	2	3	3.5	3.3	1.1	n	-29.3	07:50:54.4	+42:52:19.0	...
QSO-B0810+2554	2	1	1.1	1.5	0.7	n	-28.8	08:13:30.9	+25:45:22.9	...
QSO-J1019+2745	7	3	13.9	6.1	2.3	n	-29.3	10:19:55.6	+27:43:57.3	14.7±0.4
QSO-B1122-168	1	0	...	...	...	y	-28.9	11:24:42.9	-17:05:17.4	...
QSO-J1130-1449	2	6	1.3	1.6	0.8	y	-27.7	11:30:05.9	-14:49:42.4	...
LBQS-1435-0134	11	4	9.4	3.4	2.8	y	-28.9	14:37:47.8	-01:47:12.5	14.4±0.4
QSO-B1521+1009	6	1	5.3	2.7	2.0	n	-29.4	15:24:23.8	+09:58:29.8	14.2±0.4
QSO-B1630+3744	13	2	12.7	4.2	3.0	n	-28.3	16:32:02.3	+37:37:49.5	14.6±0.4
QSO-B1634+7037	9	3	8.2	3.3	2.5	n	-29.2	16:34:31.5	+0:31:47.1	14.4±0.4
Stack	86	45	5.8	0.9	6.6					

Table 1: Properties of the overdensities. N_{clust} is the number of spectroscopically confirmed members. N_{sl} is additional candidates with a single line which would also be at QSO redshift. δ_g is the overdensity parameter and M_B is the B band magnitude of the QSO. The final column is the estimated halo mass based on the overdensity.

References

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Bielby et al., 2019, MNRAS, 486, 21
Geach et al., 2019, ApJ, 874, 85
Silk & Rees, 1998, A&A, 331, L1