A search for companions to high redshift ($z \geq 3.0$) quasars

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Following the discovery by Djorgovski *et al.* (1985) of a companion to the high redshift quasar PKS 1614+051, we initiated a systematic search for such objects with the Danish 1.5 meter telescope at La Silla. The observing technique is CCD exposures in narrow filters (FWHM=100Å) centered on the redshifted Lyα. For an exposure time of 40 min. our limiting magnitude is around 22.0 (where the r.m.s. error is approximately ±0.15), according to test runs with DAOPHOT. The aim of the search is to clarify the nature of such companions: are they "primordial" galaxies? Lyα clouds associated with the quasar? - and how frequent is such a phenomenon? Up to now we have covered 26 fields around quasars with redshift ≥3.0 (which is about 25% of all high redshift quasars in the Veron and Veron Catalogue). Furthermore 12 fields around z≈2.5 has also been observed (see Table 1). A quick visual inspection of all our frames has not revealed any companions except for the object found by Djorgovski *et al.* (which is easily picked up by our technique). However, a thorough photometric reduction (using DAOPHOT) might reveal fainter candidates. Taken together with the fields reported observed by Hu and Cowie (1987) and Djorgovski *et al.* (1987), a total of about 50 fields have so far been observed. The preliminary conclusion is therefore that such companions, whatever they might be, are very rare, and certainly much rarer than similar systems found around quasars of low redshift.

Table 1

0045-036	0114-089	0130-403*	0249-222*	0324-407*
0334-204*	0420-388	0537-286*	0836+1122	0854+1632
0938+119*	0956+1217	1004+141*	1017+1055	1021-006
1055.4+022	1159+123*	1206+1155*	1213-002	1213+0922
1227.8+074	1320-106*	1347+1116*	1358+1134	1402+044
1429+1153	1442+101*	1510+1034	1556-245	1613.7+1715
1614+051*	1623.5+15.5	1705+018	1935-692	2126-158*
2204-408*	2227.6-395	2311-036*		

Table 1. *The 38 quasar fields observed.* All fields have narrow band Lyα observations (2x40 min.), B (40 min.) and V (20 min.) observations. Those marked with an * have also narrow band continuum observations.

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Recent work (Shaver 1988 and references therein) has now confirmed the existence of quasar-quasar clustering on scales smaller than 10Mpc, and for low (z<1.5) redshifts. At higher redshifts clustering seems to be absent on any scale from 4Mpc to 1Gpc, inferring strong clustering evolution.

The available set of deep CCD exposures in off/on Lyα bands and broad bands, of fields around known quasars, provides statistics on the sub-Mpc scale clustering at high redshifts, which is the most difficult to obtain from the larger surveys. A simple model for the qq clustering used on our preliminary results presented here, combined with those given by Hu and Cowie, and Djorgovski *et al.*, already gives a tentative result.

We assume a quasar-quasar two-point correlation function $\xi(r,z)$

$$\xi(r,z) = \left[\frac{18.4Mpc}{r}\right]^{1.8}(1 + z)^{-\alpha} \qquad (1)$$

where the amplitude of the clustering is chosen so that $\xi(r{=}10Mpc,\ z{=}0)\approx 3$ (Shaver, 1988). With the present observational material (50 CCD frames to a conservative limit of B<22.5, containing no counts), we can set lower limits on the clustering evolution parameter α, depending on the expec-ted quasar surface density as shown in Fig. 1. The horizontal dotted line in Fig. 1 marks the value α=1.2 (stable clustering), whereas the vertical dashed lines marks the values N=25 (expected from pure luminosity evolution, Weedman (1985)) and N=15 (suggested by the latest high redshift quasar surveys).

It is interesting to note that the discrepancy between the value of N expected from pure luminosity evolution and the observed value, seems to arise solemnly from the low luminosity objects, i.e. the bright quasars are there, only the faint ones are missing. This could suggest that the evolution of the two-point correlation function reflects an environmental dependence on quasar formation and/or evolution, rather than the cosmological evolution of large scale structures.

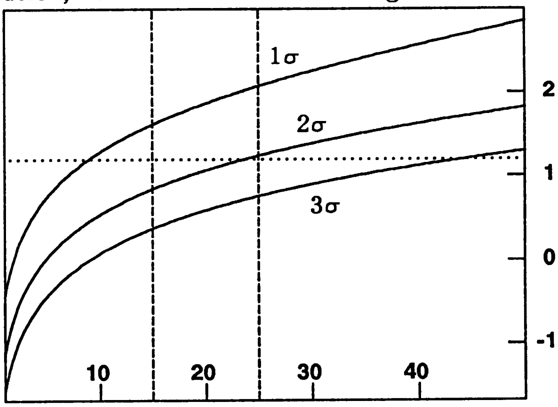

Figure 1. *The "clustering evolution parameter" (α) as defined by (1), versus the number of quasars per unit redshift interval, per square degree, at a redshift of 3, and with B<22.5 (N). 1, 2 and 3σ lower limits on α from preliminary results from a total of 50 fields around high redshift quasars, is shown (q_0=½ and h=1 assumed).*

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