Luminosity Dependence of the Quasar Clustering from SDSS DR5

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51757 objects, which were primarily identified as quasars in SDSS DR5 and have spectroscopic redshifts were used to study a luminosity dependence of the quasar clustering with the help of two different techniques. The obtained results reveal a weak luminosity dependence, which is in agreement with the results by Porciani & Norberg (2005) and theoretical predictions by Hopkins et al. (2005).

Theoretical predictions

numerical simulations of galaxy mergers that incorporate black hole growth

most semi-analytic models (e.g. Kauffmann & Haehnelt, 2000)

strong dependence between the **instantaneous** quasar luminosity and the host DM halo mass → faint quasars populate low-M halos

faint quasars have to be less clustered then bright ones

Hopkins et al. (2005)

bright and faint quasars are similar sources at different stages of their evolution and reside similar halos + strong dependence between the **peak** quasar luminosity and the host DM halo mass

quasar clustering depends **less** strongly on luminosity

The data

51757 objects, which were primarily identified as quasars in SDSS DR5 (Adelman-McCarthy et al. 2007) and have spectroscopic redshifts *(http://www.sdss.org/dr5/products/spectra/getspectra.html)*

5 redshift intervals: 0.3..0.8, 0.8..1.2, 1.2..1.5, 1.5..1.8, 1.8..2.2 (about 10000 object in each)

3 Mg intervals: 'bright', 'medium', 'faint' (about 3000 object in each)

Cosmological model

All absolute magnitudes and distances were calculated within the frame of ΛCDM-model with spatially flat Universe

$$\Omega_{tot} = 1$$

$$\Omega_M = 0.29$$

$$h = 0.73$$

(Spergel D.N., et al. arXiv:astro-ph/0603449)

The methods

The first method

Calculation of the real-space correlation function (cross correlation quasar (Mmin<M<Mmax) - quasar (any M)):

$$\xi(r) = \left(\frac{r}{r_0}\right)^{\gamma}$$

r_0 – correlation length
γ – slope of the correlation function

The second method

$$f(r, M_g) = \frac{N(r_{NN} < r, M_{g,\min} < M_g < M_{g,\max})}{N_{tot}(M_{g,\min} < M_g < M_{g,\max})}$$

r_{NN} – distance to the first nearest neighbour with any Mg

* White (1979): $g(r) = \frac{N(r_{NN} > r)}{N_{tot}}$ an estimate of the probability, that the volume of radius r is empty - a complementary statistics to the correlation function. Relation between *f(r)* and *g(r)*: $g(r) + f(r) = 1$.

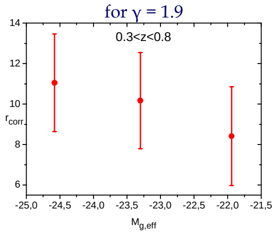
If the quasar clustering is L-independent → $f(r,M_g) \neq f(M_g)$. For verification of this statement 100 artificial samples were generated from the each sample by permutation of Mg of their objects in random way. (For each sample *f(r)*-curves for different M_j coincide within 1σ-level, as one can see from the plots)

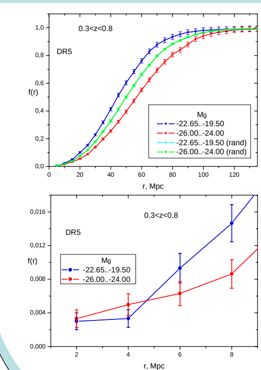
Parameters of the correlation function

z	N_1	M_g	eff. M_g	N_2	2-parametric model		1-parametric model	
					γ	r_{corr}, h^{-1} Mpc	r_{corr}, h^{-1} Mpc (γ=1.9)	r_{corr}, h^{-1} Mpc (γ=1.7)
0.3-0.8	10992	-22.65..-19.50	-21.94	3002	1.47±0.37	13.61±4.07	8.41±2.44	9.67±3.01
		-23.70..-22.90	-23.30	2992	2.32±0.34	9.57±1.73	10.17±2.48	10.46±2.87
		-26.00..-24.00	-24.58	3012	2.16±0.38	10.04±1.72	11.05±2.31	12.12±3.23
0.8-1.2	10641	-24.55..-22.00	-23.98	3085	2.49±0.22	10.48±1.30	12.63±1.71	13.38±2.15
		-25.20..-24.70	-24.95	3215	2.74±0.13	8.87±0.58	9.38±1.30	8.52±1.59
		-28.00..-25.30	-25.82	3039	1.42±0.23	8.87±1.18	7.62±0.70	8.10±0.77
1.2-1.5	9068	-25.35..-22.00	-24.87	2958	1.61±0.14	17.05±1.29	14.62±0.85	16.20±0.95
		-25.85..-25.35	-25.60	3071	2.65±0.26	10.18±0.81	9.77±1.85	9.07±2.28
		-28.00..-25.85	-26.34	3013	2.57±0.25	9.58±0.95	9.44±1.80	9.40±2.20
1.5-1.8	10923	-25.65..-24.00	-25.22	3026	2.25±0.40	11.30±1.50	9.23±2.90	9.12±3.02
		-26.25..-25.80	-26.03	3133	2.22±0.43	9.00±1.38	8.23±1.91	7.84±2.18
		-29.00..-24.60	-26.87	3009	1.92±0.50	9.98±1.98	9.57±1.41	9.86±1.68
1.8-2.2	10127	-26.10..-24.00	-25.66	2969	2.32±0.41	11.77±1.77	11.46±2.44	11.48±3.03
		-26.75..-26.20	-26.49	3123	2.62±0.28	11.47±0.87	9.91±1.37	9.12±1.61
		-29.00..-26.85	-27.32	3007	2.10±0.50	8.36±1.91	7.84±2.14	7.38±2.26

0.3<z<0.8 (10992 quasars)
N (-22.65..-19.50) = 3002
N(-23.70..-22.90) = 2992
N (-26.00..-24.00) = 3012

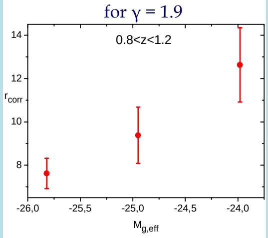
for γ = 1.9

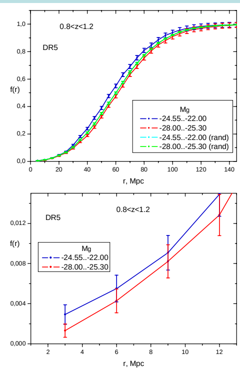




0.8<z<1.2 (10641 quasars)
N (-24.55..-22.00) = 3085
N(-25.20..-24.70) = 3215
N (-28.00..-25.30) = 3039

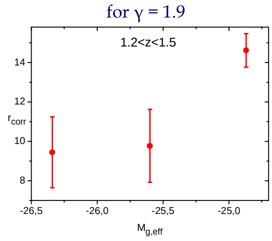
for γ = 1.9

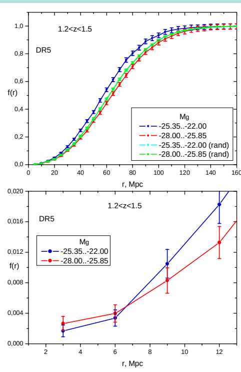




1.2<z<1.5 (9068 quasars)
N (-25.35..-22.00) = 2958
N(-25.85..-25.35) = 3071
N (-28.00..-25.85) = 3013

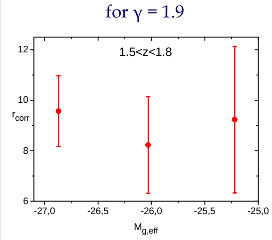
for γ = 1.9

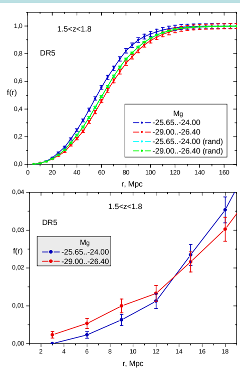




1.5<z<1.8 (10923 quasars)
N (-25.65..-24.00) = 3026
N(-26.25..-25.80) = 3133
N (-29.00..-26.40) = 3009

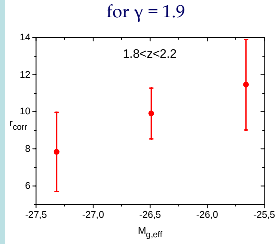
for γ = 1.9

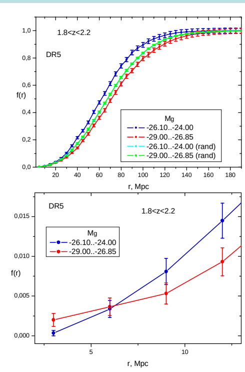




1.8<z<2.2 (10127 quasars)
N (-26.10..-24.00) = 2969
N(-26.75..-26.20) = 3123
N (-29.00..-26.85) = 3007

for γ = 1.9





Conclusions

1) The obtained values of the parameters of the correlation function with constant slope for 0.8<z<1.5 indicate that the faint quasars have larger r_{corr} (on 2-sigma level).
2) Splitting of the f-curves for different M reveals the presence of the L-dependence up to the scales of the Universe heterogeneity for all redshift intervals. The higher values of f(r) on the small scales for brighter quasars are an evidence for their stronger clustering (more than 1σ-level for redshifts close to peak of the quasar activity)
3) The results are an evidence for **a weak luminosity dependence**, which is in agreement with the results by Porciani & Norberg (2005) and theoretical predictions by Hopkins et al. (2005).