The Low Redshift Clustering of SDSS QSOs

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10-2-2007 / CCAPP AGN Workshop
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The QSO Sample

- SDSS DR5 QSO Sample (Schneider et al)
- $i < 19.1$
- Primary objects, stellar morphologies
- Few thousand QSOs
Sky/\ z-Coverage

Restricted to lie within LRG mask

Three \( z \) subsamples, chosen to maximize overlap with LRG samples:

- \( 0.25 < z < 0.35 \)
- \( 0.33 < z < 0.50 \)
- \( 0.45 < z < 0.60 \)
Photometric LRGs

- $\Delta z \sim 0.03$
- $0.25 < z < 0.6$
- Six photo-z slices, $\Delta z = 0.05$
- $\bar{n} \sim 4 \times 10^{-4} (\text{Mpc}/h)^2$
- NP et al, 2007
Clustering Estimators

- Use the small scale estimator, $\omega$ in NP, White, Eisenstein, 2007
- Weighted integral of $w_p$ or $w_\theta$
- $R_s \sim R/2$
- Unbinned, insensitive to large scales
- LRGs: Only photoz’s, so angular clustering
- QSO-LRGs: Use the QSO redshift to work in physical units
LRGs: \(0.25 < z_p < 0.35\)

\[0.25 < z < 0.35\]

\(b = 1.77 \pm 0.05\)

\(b = 1.74 \pm 0.04\)
LRGs: \(0.35 < z_p < 0.45\)

\[
0.33 < z < 0.50 \\
\frac{b}{10^2} = 2.31 \pm 0.04
\]

\[
\frac{b}{10^2} = 2.27 \pm 0.03
\]
LRGs: $0.45 < z_p < 0.55$

$0.45 < z < 0.60$

$b = 2.00 \pm 0.04$

$b = 1.82 \pm 0.05$
QSO-LRG cross-correlations

$0.25 < z < 0.35$

\[ b(z)D(z) = 1.20 \pm 0.37 \]
QSO-LRG cross-correlations

$0.33 < z < 0.50$

$$b(z)D(z) = 0.77 \pm 0.28$$
QSO-LRG cross-correlations

$0.45 < z < 0.60$

$$b(z)D(z) = 0.99 \pm 0.42$$
Split the sample into bright and faint samples
- Bright: $b = 1.58 \pm 0.37$
- Faint: $b = 0.67 \pm 0.25$

L-dependence?

Most of the effect from the low-z slice ($1.8 \pm 0.5$, vs. $0.7 \pm 0.4$)
Halo Masses

- Fit Smith et al from $R > 1 \, h/\text{Mpc}$
- $\log(M) \sim 12 \pm 1$
Back of the Envelope Interpretations

**Eddington ratios**
- \( M_{halo} \sim 10^{12} M_\odot \)
- \( V_{circ} \sim 150 \text{ km/s} \)
- \( M_{bh} \sim 10^8 M_\odot \)
- \( L_{edd} \sim 10^{12.5} L_\odot \)
- \( L_{bol} \sim 10^{12.25} L_\odot \)
- \( L/L_{edd} \sim 0.5 \)

**Duty Cycles**
- \( n_Q \sim 1.5 \times 10^{-6} \)
- \( n_{halo} \sim 3 \times 10^{-3} \)
- Duty cycle: \( O(0.1\%) \)
Small Scale Correlations

- Average slices 1 and 3
- Cross-correlation looks like scaled version of auto-correlation
- No excess on small scales
Questions?

- What clustering measurements give the most leverage to constrain models?
- L-dependence of clustering?
- How to model small scale clustering?