Hierarchical amplitudes in the CFHTLS Wide Survey: Evolution since ~1

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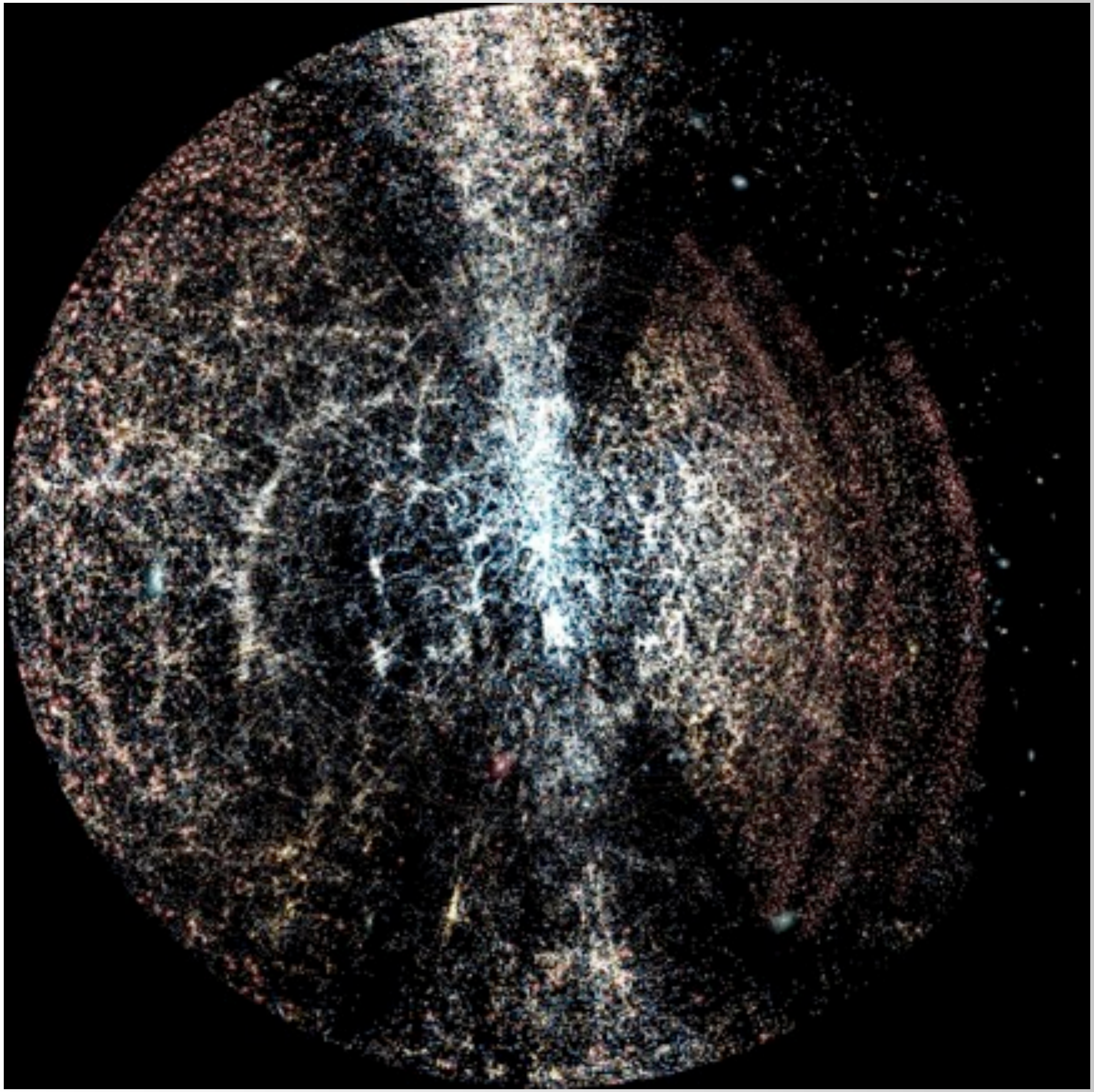
Introduction



The traditionnal tool: the two point correlation function

$$dP_{12} = n^2[1 + \xi(\mathbf{r}_{12})]dV_1 dV_2$$

Enough for gaussian random fields.

Non gaussian probes : **higher order statistics**.

Goal of this analysis : study the evolution with redshift of the cumulants of the galaxy distribution.

Previous studies: Szapudi et al. 2001

High order clustering

The factorial moments of the number of galaxies are closely related to those of the underlying field by:

$$\langle N^{[k]} \rangle = \langle N(N-1)\cdots(N-k+1) \rangle = \bar{N}^k \bar{\mu}_k$$

where $\langle N^{[k]} \rangle$ is called the k^{th} factorial moment and $\langle \mu_k \rangle$ are: $\bar{\mu_k} = \frac{1}{V^k} \int_V dr_1 ... dr_k \mu_k(r_1, ...r_k)$

If we separate $\langle \mu_k \rangle$ into irreducible contributions we get:

$$\bar{\mu}_2 = 1 + \bar{\xi}_2$$
$$\bar{\mu}_3 = 1 + 3\bar{\xi}_2 + \bar{\xi}_3$$
$$\bar{\mu}_4 = 1 + 6\bar{\xi}_2 + 3\bar{\xi}_2^2 + 4\bar{\xi}_3 + \bar{\xi}_4$$
$$\bar{\mu}_5 = 1 + 10\bar{\xi}_2 + 10\bar{\xi}_3 + 15\bar{\xi}_2^2 + 10\bar{\xi}_2\bar{\xi}_3 + 5\bar{\xi}_4 + \bar{\xi}_5$$

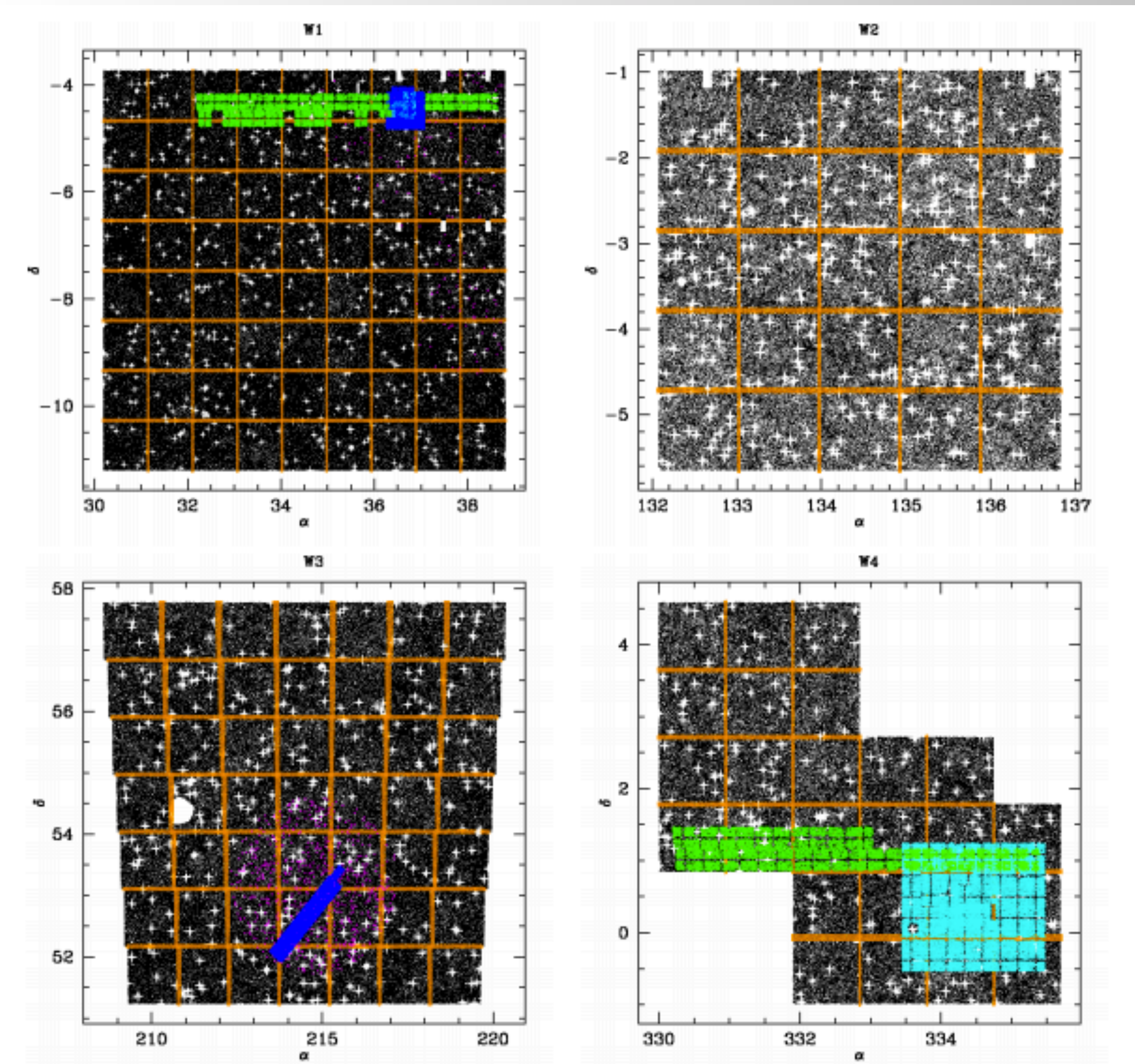
The probability of counts in cells, $P_N(\theta)$, is the probability that a cell of dimension θ contains N objects. It is straightforward to calculate the factorial moments from the CIC: $F_k \equiv \sum_N P_N N^{[k]}$

And then we can deduced the hierarchical amplitudes:

$$S_k = \frac{\bar{\xi}_k}{\bar{\xi}_2^{k-1}}$$

$$S_N = \frac{\bar{\xi} F_N}{N_c^N} - \frac{1}{N} \sum_{k=1}^{N-1} \binom{N}{k} \frac{(N-k) S_{N-k} F_k}{N_c^k}$$

The CFHTLS data



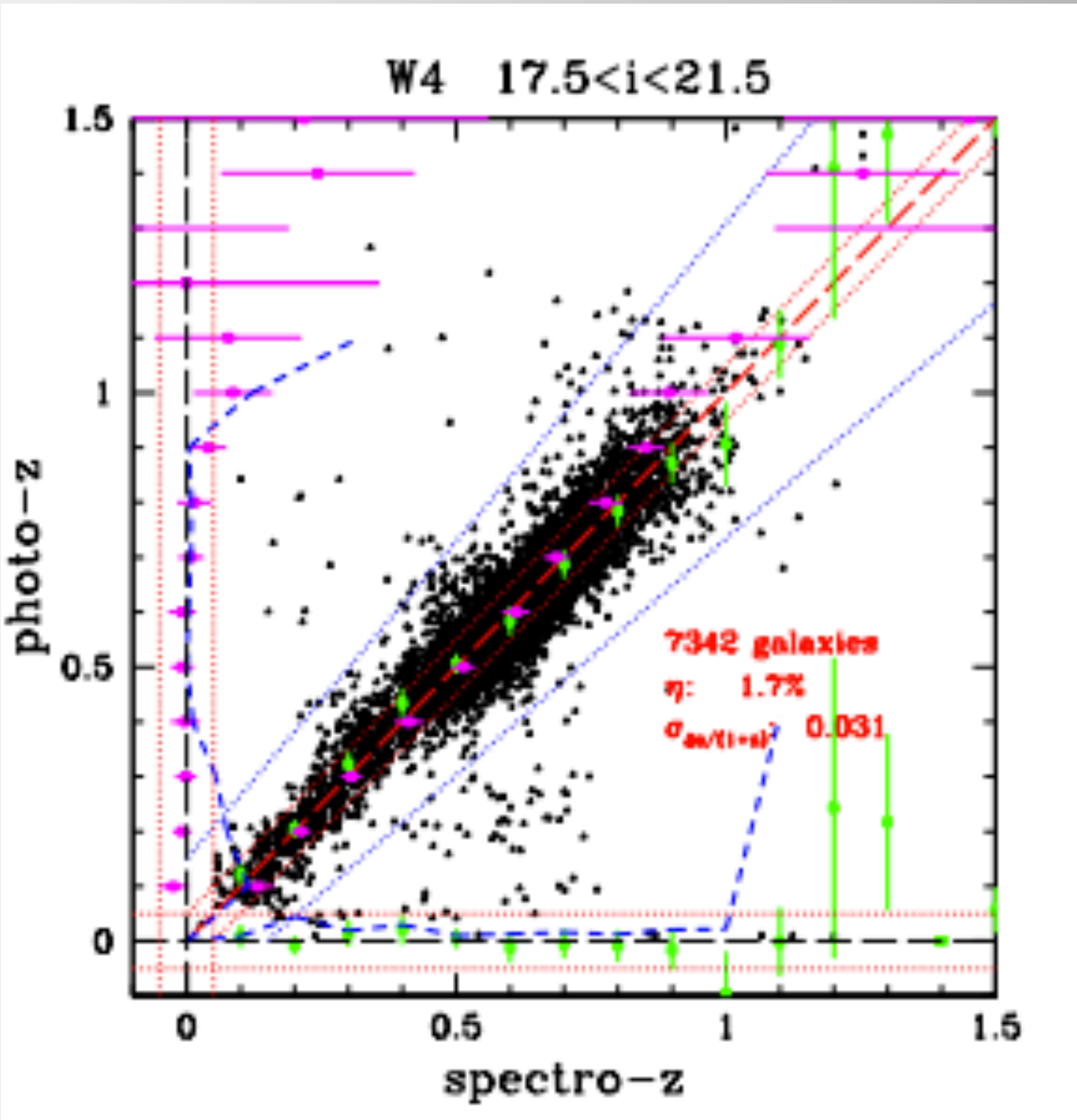
Covers **160 deg^2**

All fields are observed in **u*, g, r, i, z** filters.

Objects selected with **i<22.5**

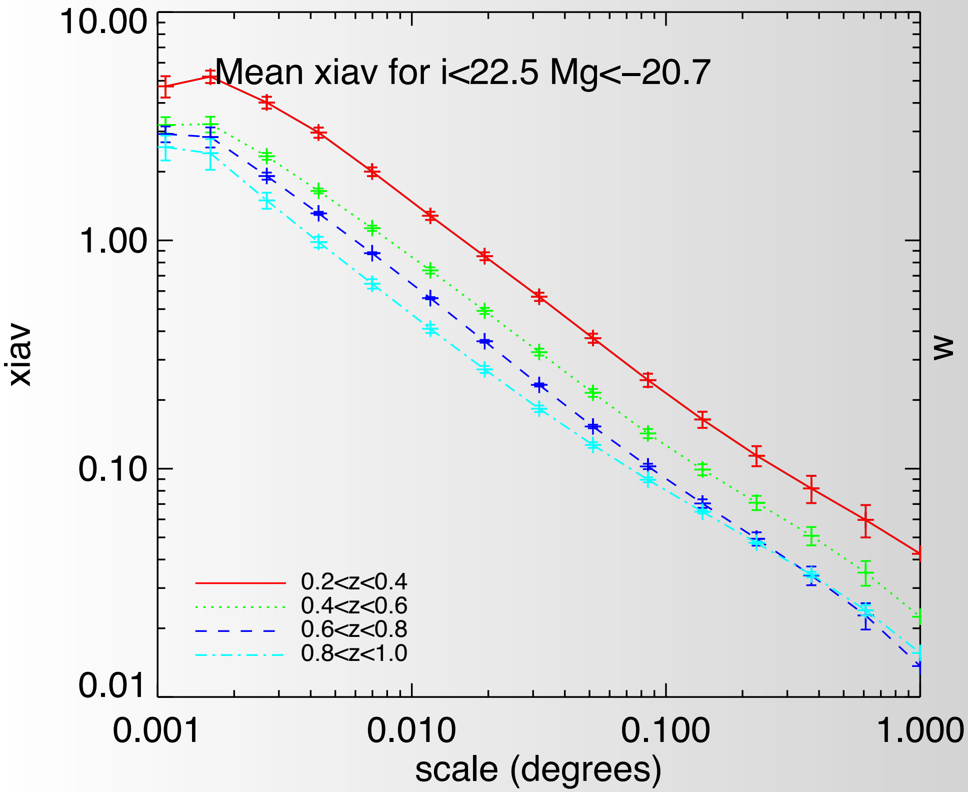
More than **1 500 000 objects with photometric redshifts** between **0<z<1.**

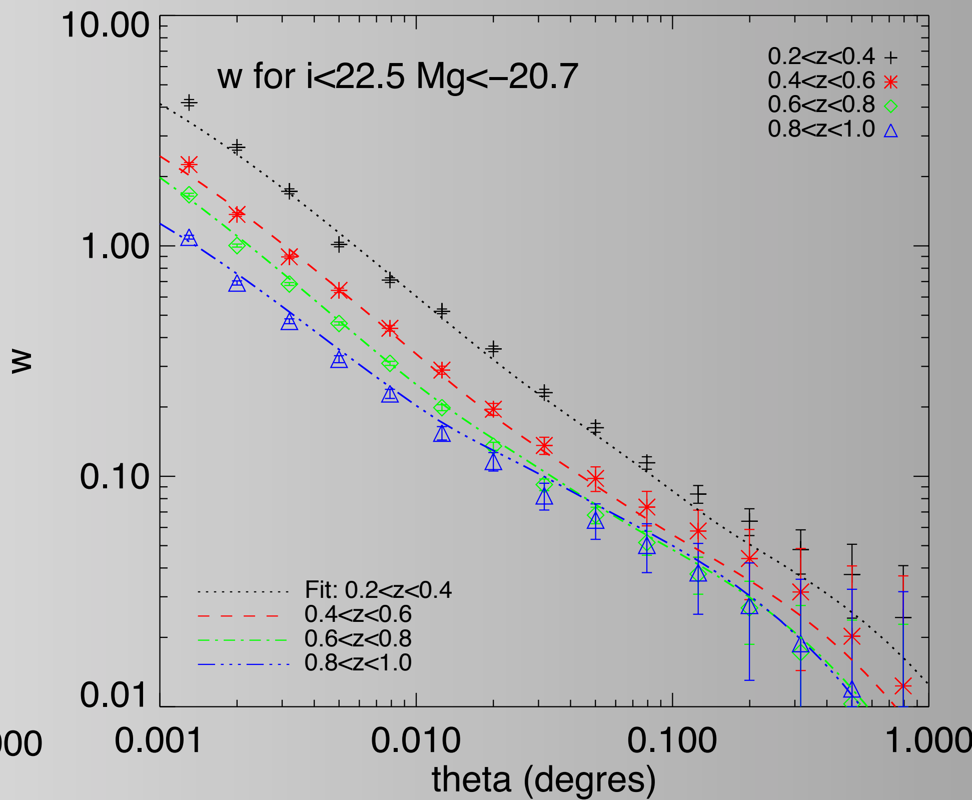
Photometric data



The two point correlation function

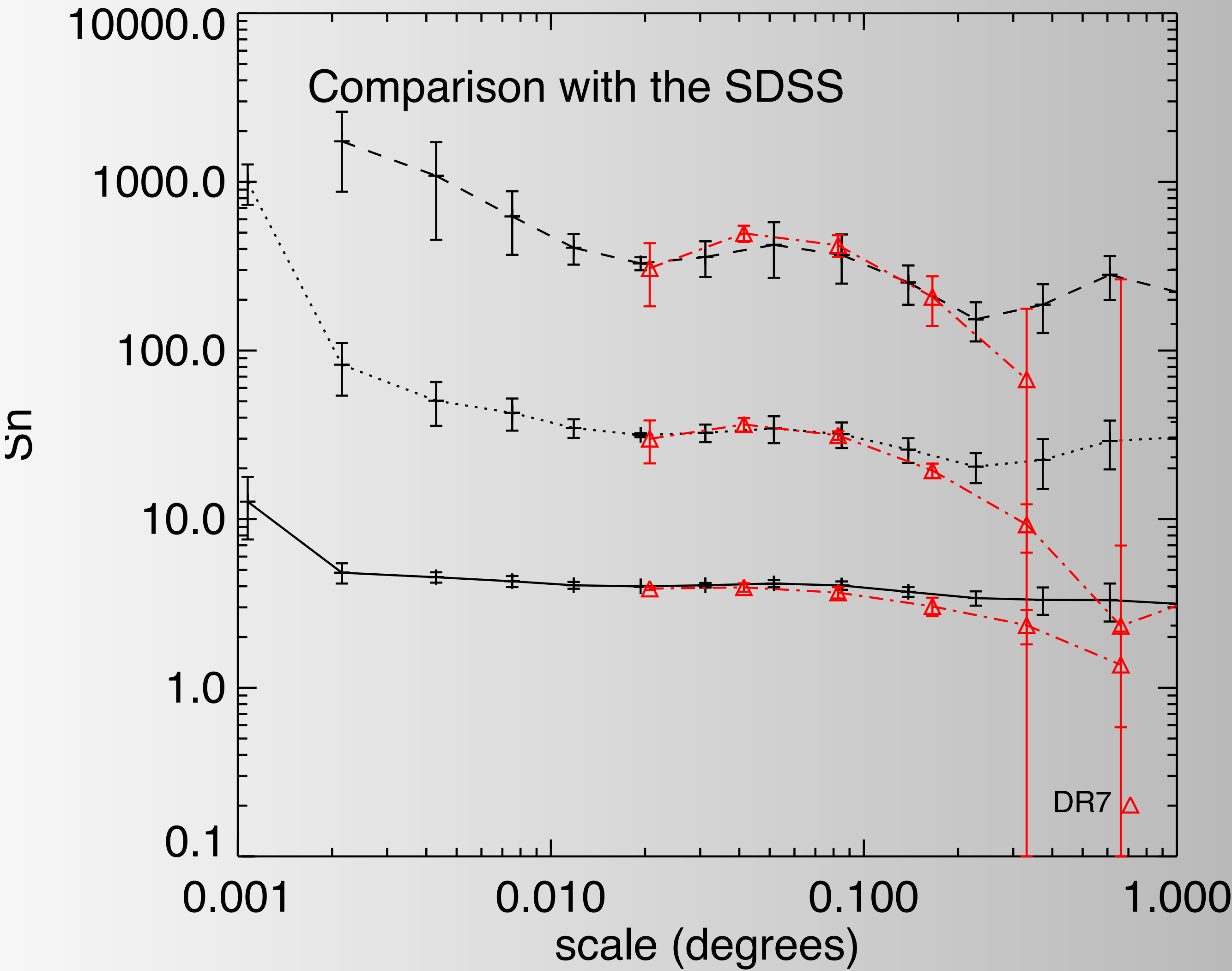
We choose a volume limited sample with i<22.5 and Mg<-20.7





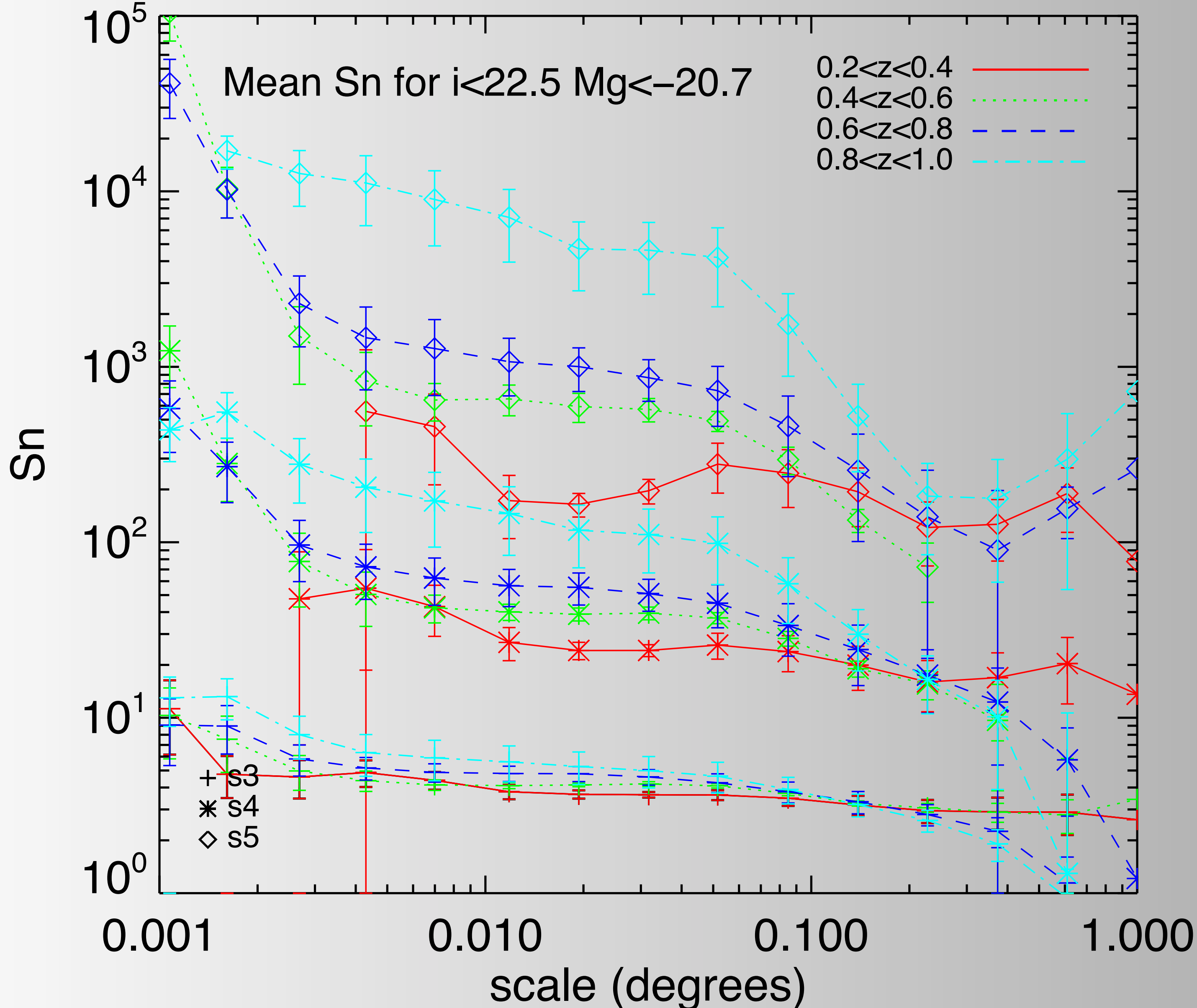
$$w(\theta) = \frac{N_r(N_r - 1)}{N_d(N_d - 1)} \frac{\langle DD \rangle}{\langle RR \rangle} - \frac{N_r - 1}{N_d} \frac{\langle DR \rangle}{\langle RR \rangle} + 1$$

Comparison with the SDSS



We made a sample comparable to the one in Ross et al. 2007 which corresponds to 0<z<0.4, 18<r<21 and Mr<-20.5. The red dots are obtained using the DR7 release of the SDSS.

Measurements of high order clustering



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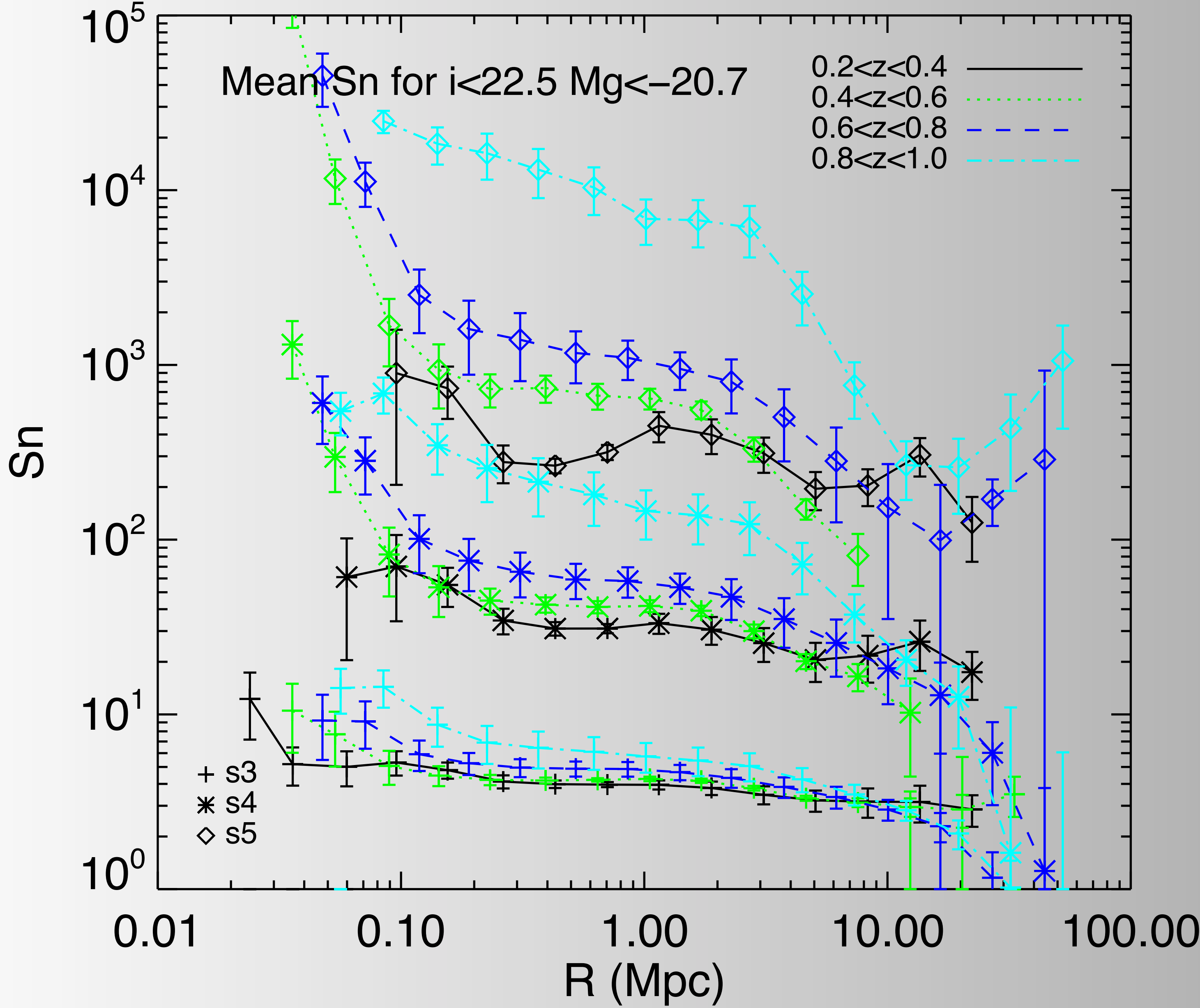
Deprojection



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Halo model

Hypothesis: parameters of the halo occupation function only depend on halo mass

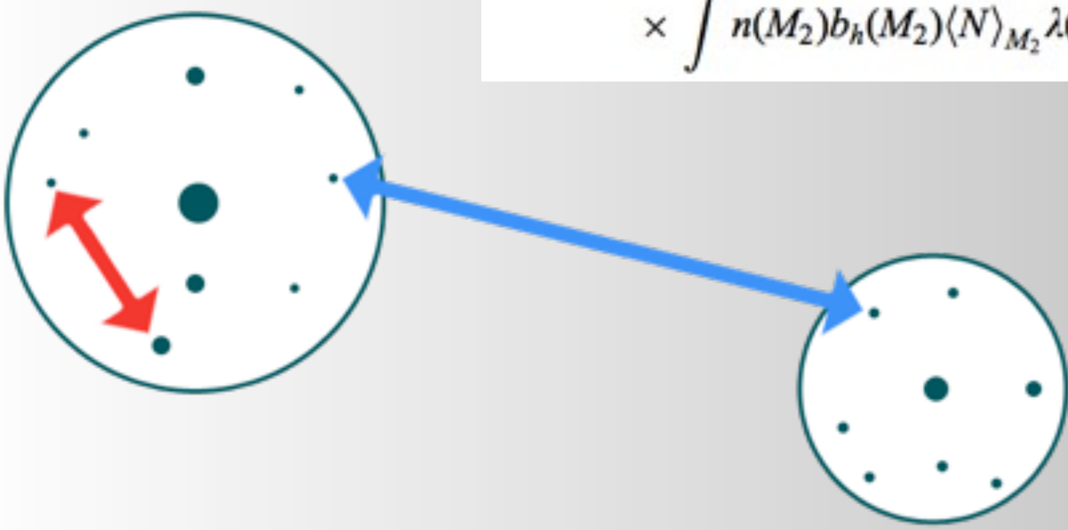
The two point correlation function is the sum of 2 terms:

- Pairs of galaxies within the same DM halo: dominant on small scales, depends on galaxy properties

$$1 + \xi^{1\mathrm{h}}_{\mathrm{gg}}(r) = \frac{1}{2}\bar{n}_g^{-2}\int n(M)\langle N(N-1)\rangle_M \lambda(r|M)\,dM$$

- Pairs of galaxies in separate DM halos: dominant on large scales, linearly follows the DM

$$\xi^{2\mathrm{h}}_{\mathrm{gg}}(r) = \xi^{\mathrm{lin}}_{\mathrm{mm}}(r)\bar{n}_g^{-2}\int n(M_1)b_h(M_1)\langle N\rangle_{M_1}\,dM_1 \times \int n(M_2)b_h(M_2)\langle N\rangle_{M_2}\lambda(r|M_1,M_2)\,dM_2$$

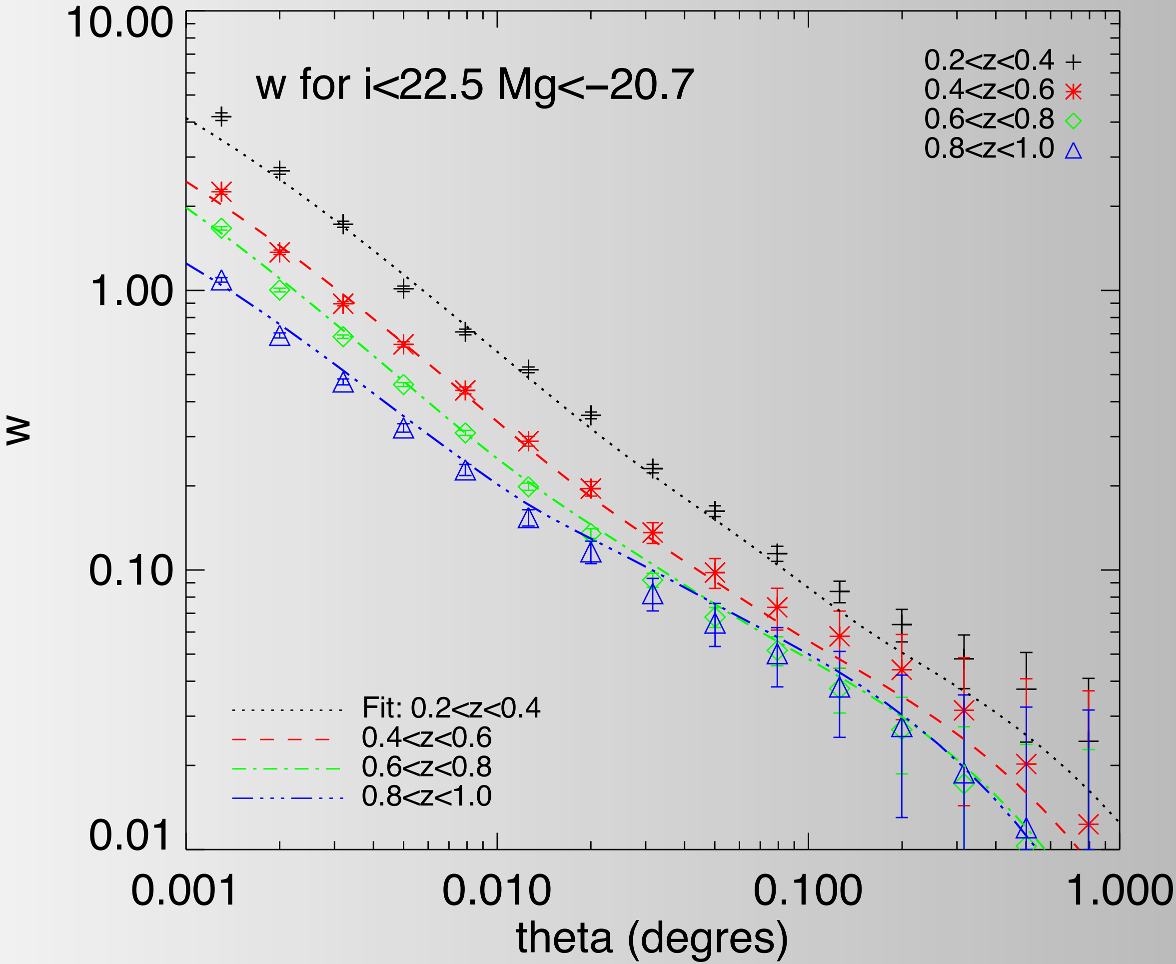


$$N(M) = N_{\mathrm{c}}(M) \times [1 + N_{\mathrm{s}}(M)]$$

$$N_{\mathrm{c}}(M) = \frac{1}{2}\left[1 + \mathrm{erf}\left(\frac{\log M - \log M_{\min}}{\sigma_{\log M}}\right)\right],$$

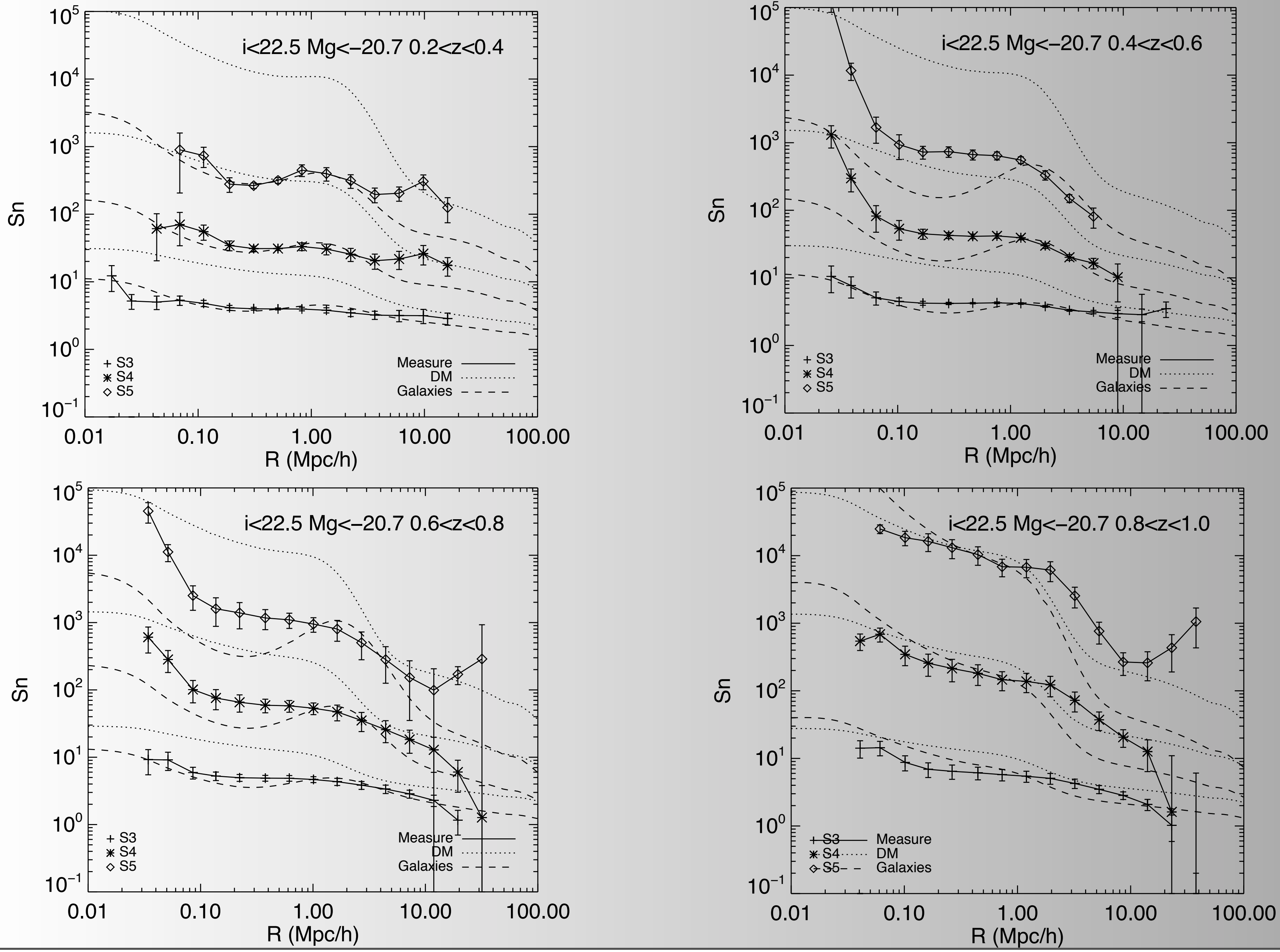
$$N_{\mathrm{s}}(M) = \left(\frac{M - M_0}{M_1}\right)^{\alpha}.$$

Fit HOD



z	M_{min}	M_{max}	α
$0.2 < z < 0.4$	$12.30^{+0.10}_{-0.15}$	$14.63^{+0.24}_{-0.42}$	$1.1637^{+0.03}_{-0.03}$
$0.4 < z < 0.6$	$12.29^{+0.05}_{-0.07}$	$14.87^{+0.37}_{-0.70}$	$1.076^{+0.03}_{-0.05}$
$0.6 < z < 0.8$	$12.28^{+0.03}_{-0.04}$	$15.05^{+0.30}_{-0.35}$	$1.1337^{+0.02}_{-0.03}$
$0.8 < z < 1.0$	$11.99^{+0.02}_{-0.03}$	$14.94^{+0.8}_{-0.6}$	$1.4406^{+0.05}_{-0.03}$

Prediction SNS



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Conclusion

In this study we were able:
-to measure the high order cumulants in the CFHTLS Wide
-to see the evolution of the SNs with the redshift

In a future work, we plan to:
-directly fit the halomodel parameters on the SNs
-add constraints from S3 to our HOD fitting to better adjust the transition between the one-halo and the two-halo term
-look at the evolution of the high order clustering on different populations of galaxies