MEASURING THE GROWTH RATE THROUGH CROSS-CORRELATIONS: FIRST APPLICATION TO VIPERS

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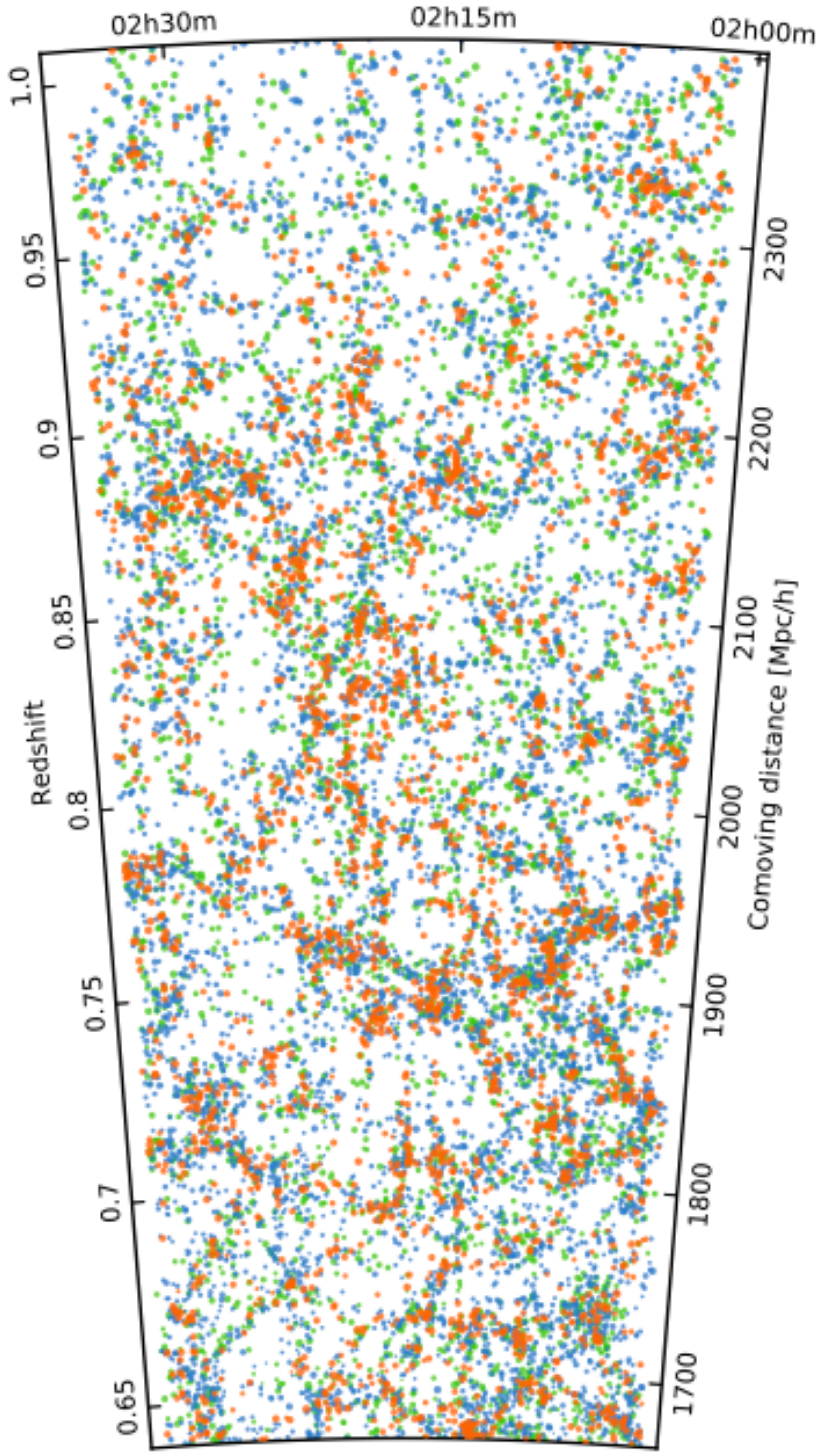
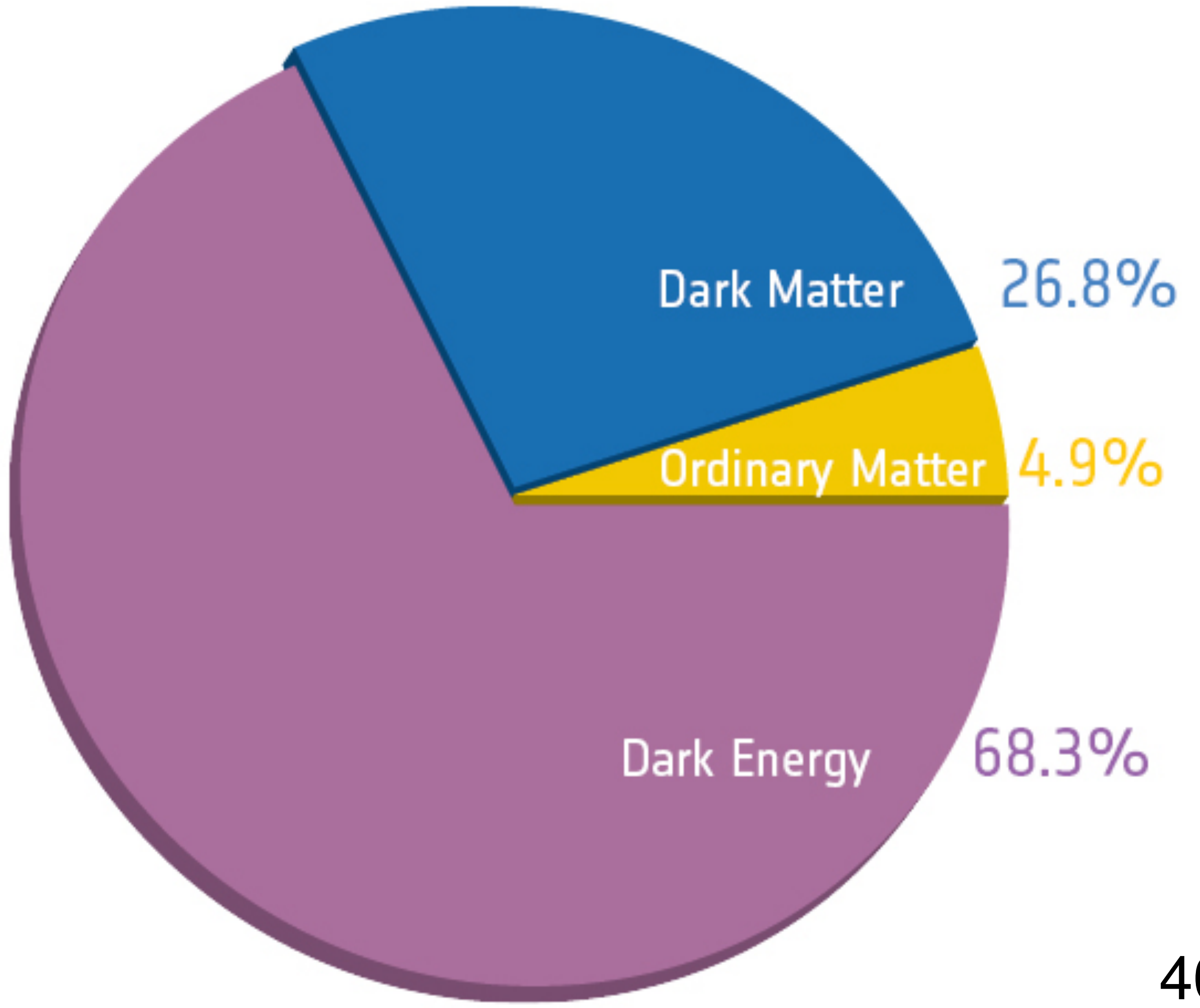
OUTLINE

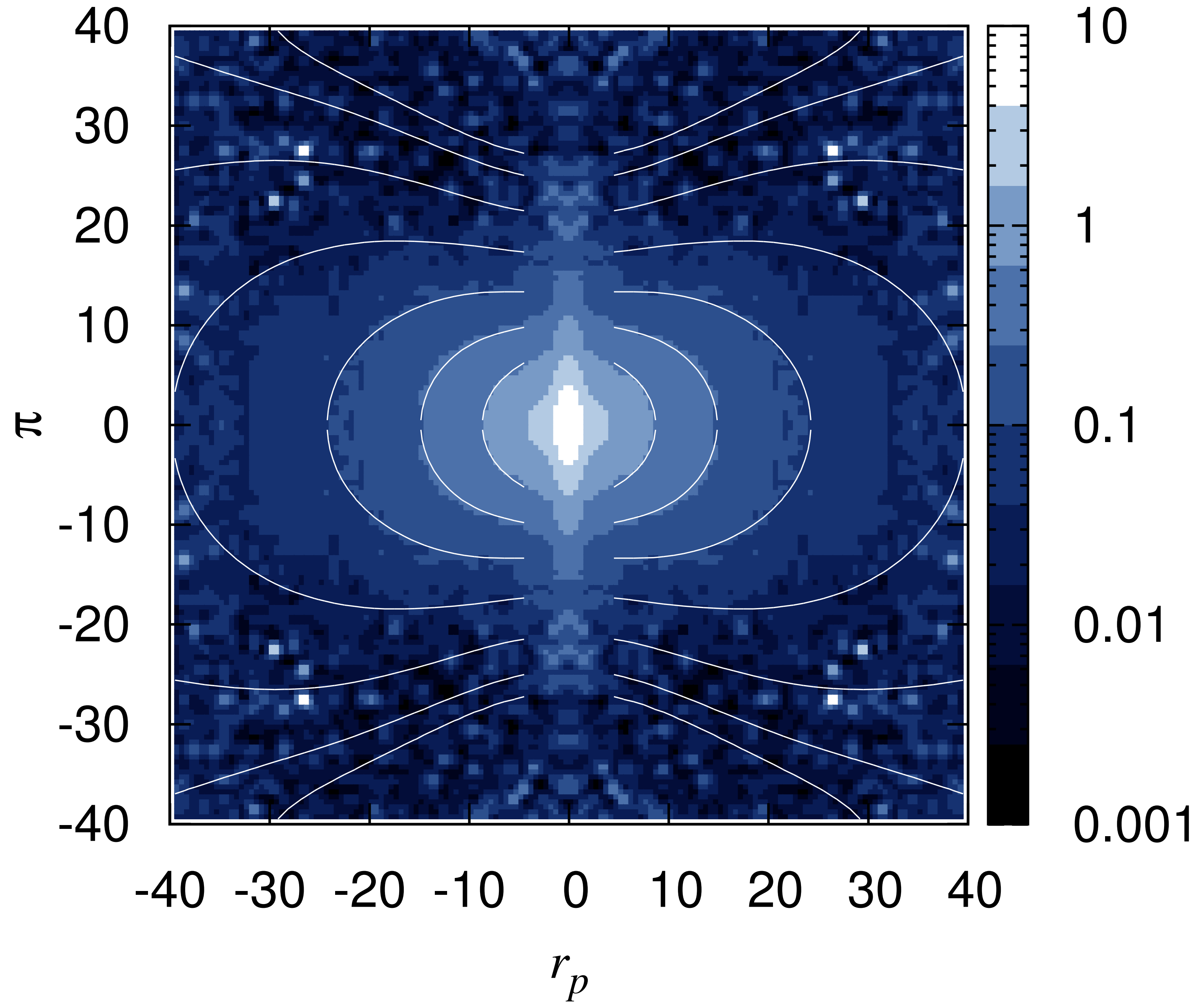
- RSD from multi-tracers cross-correlation;
- The VIPERS survey: selecting blue/red galaxies;
- First growth rate results from full survey;



Background

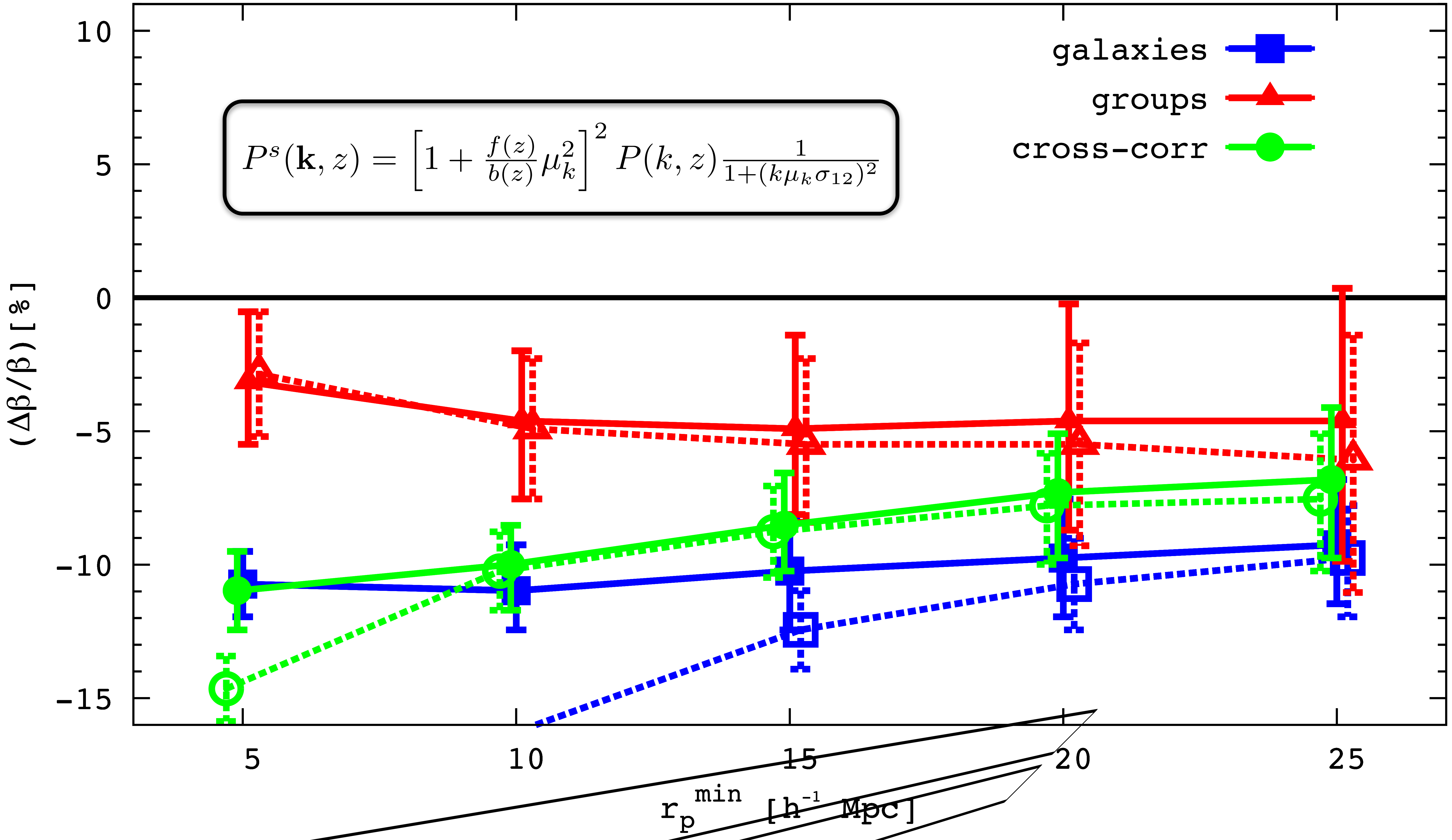


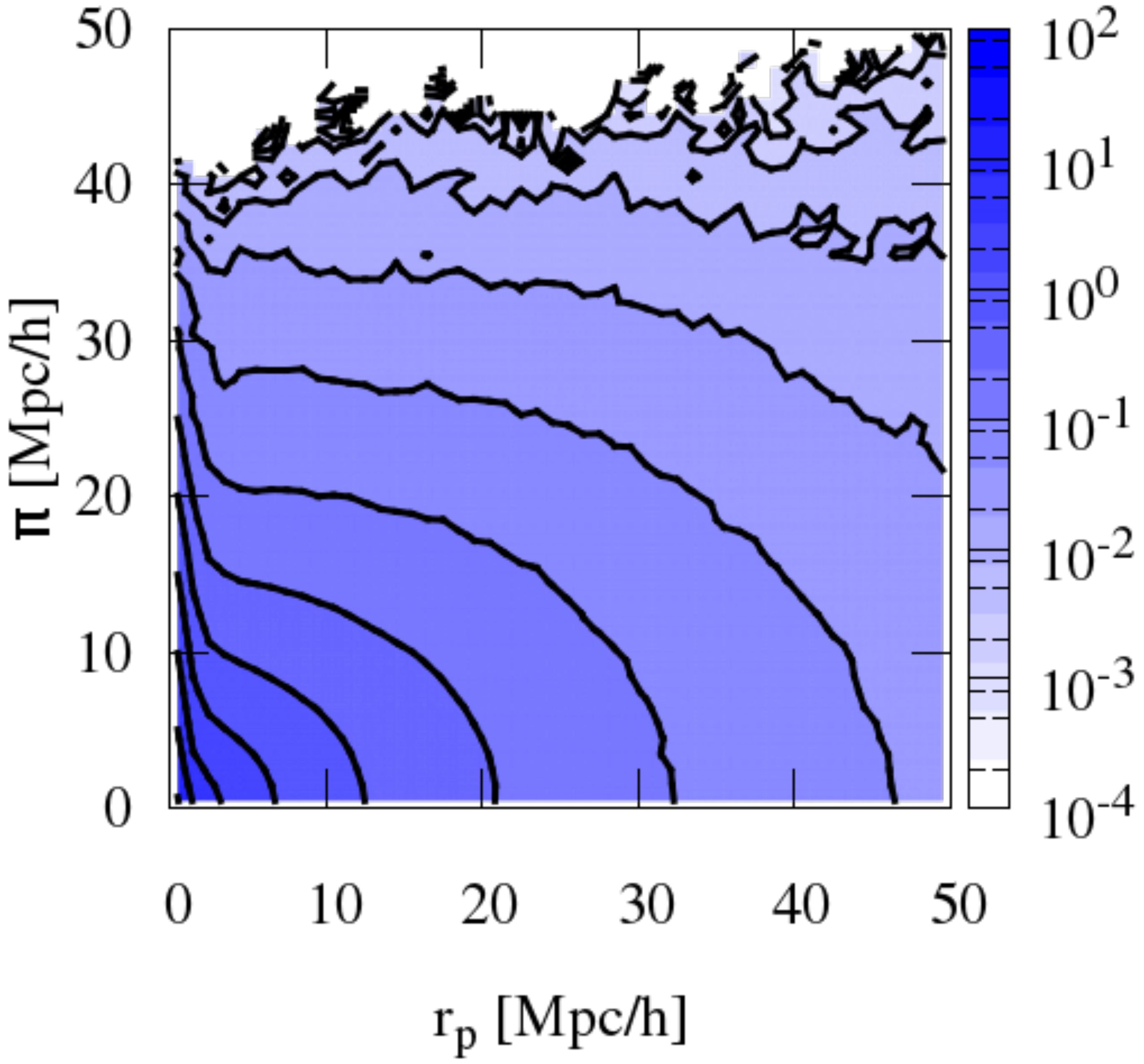
- Observations: accelerated expansion;
- GR+DE or modified gravity?
- Expansion history alone cannot distinguish between gravity models;
- Breaking degeneracy: Growth of structure;
- Use Redshift Space Distortions (RSD);



de la Torre et al. 2013

RSD Modelling Limitations

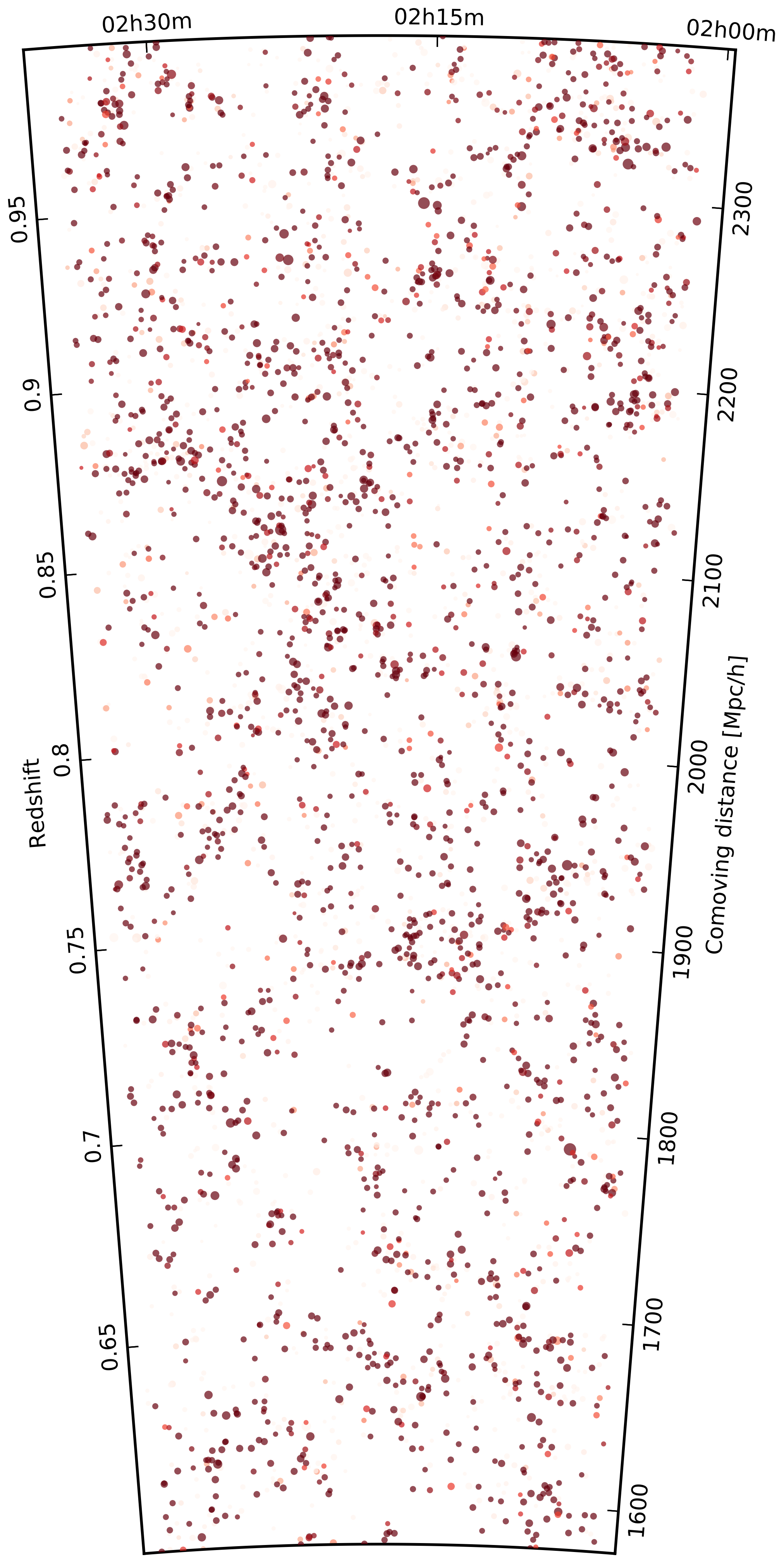




Mohammad et al. 2015 (arxiv 1502.05045)

(see also e.g. Okumura&Jing 2011, Bianchi et al. 2012)

APPLICATION: VIMOS PUBLIC EXTRAGALACTIC REDSHIFT SURVEY



Red

Redshift range: **0.5 < z < 1.2**

Large comoving volume: **~4x10^7 [h^{-3}Mpc^3]**

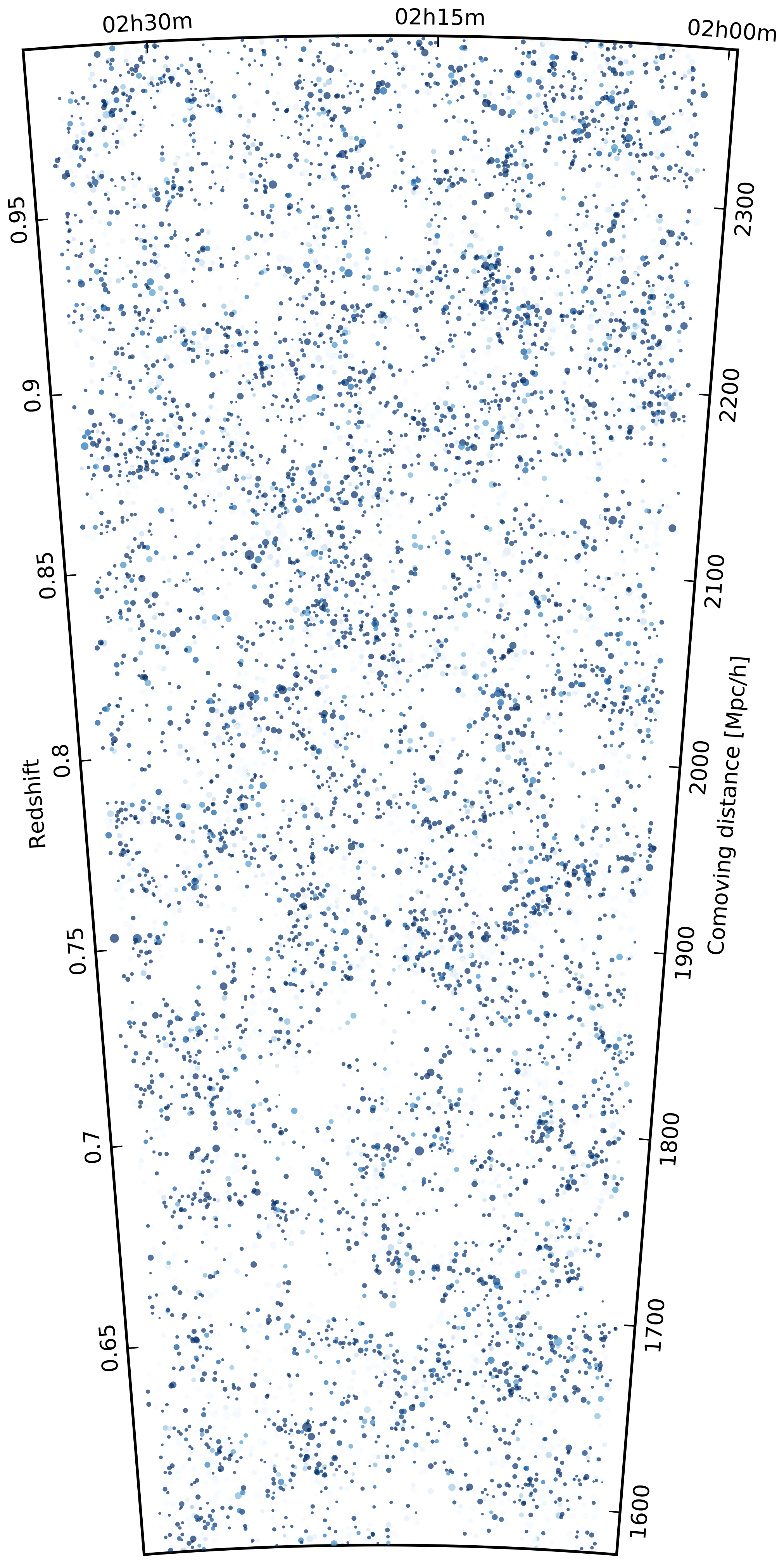
Spectroscopic redshifts of **~90,000 galaxies**

Highly sampled **~10^{-2} [h^{3}Mpc^{-3}]**

Blue population to trace coherent flow

Red population: virialized component

select vol. lim. catalogues (in 0.6<z<1.0)

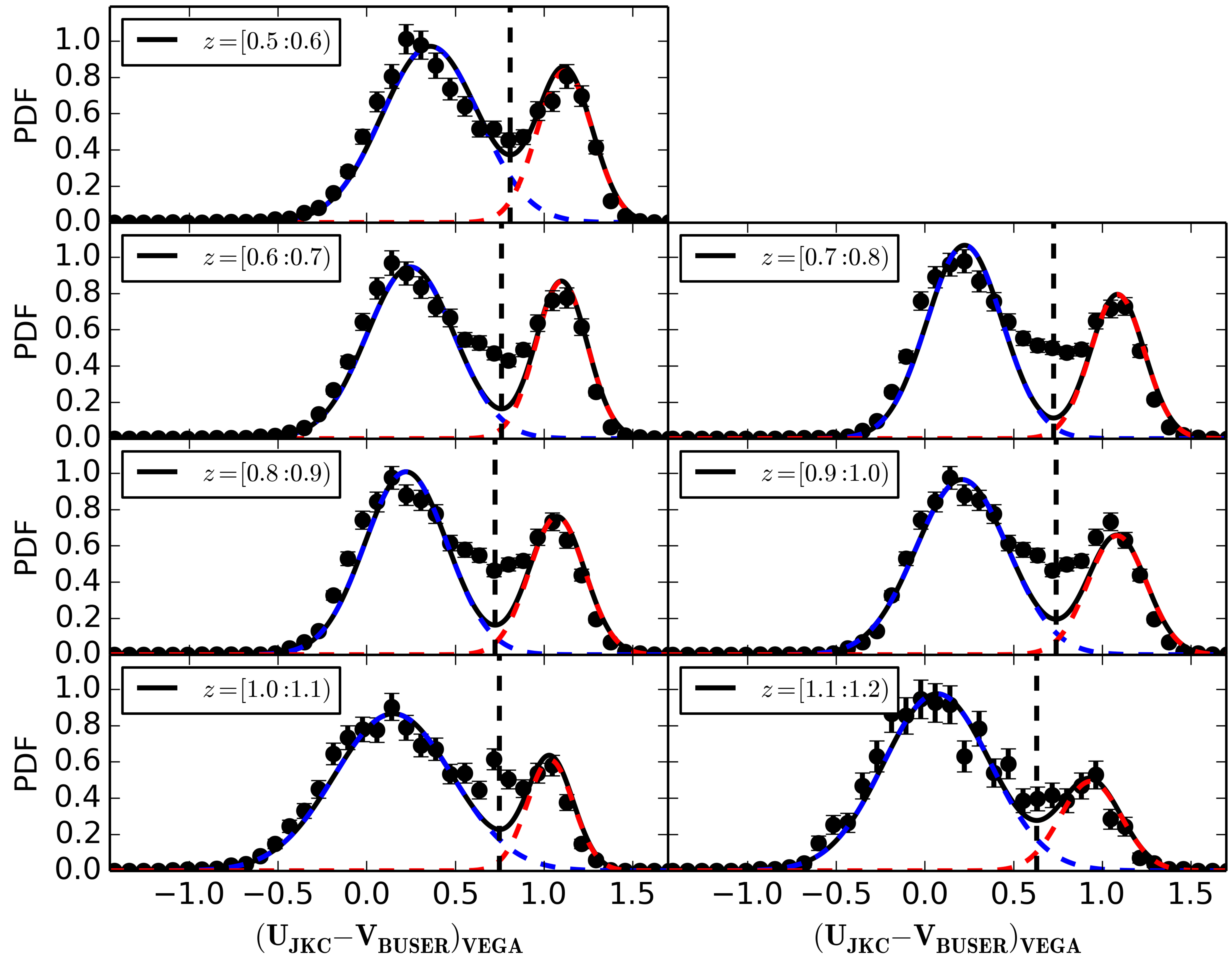


Blue

Blue/Red Classification

- **Bimodality** in (U-V) colours
- **Double gaussian model**
- **Redshift dependence**

  (Fritz et al. 2014)



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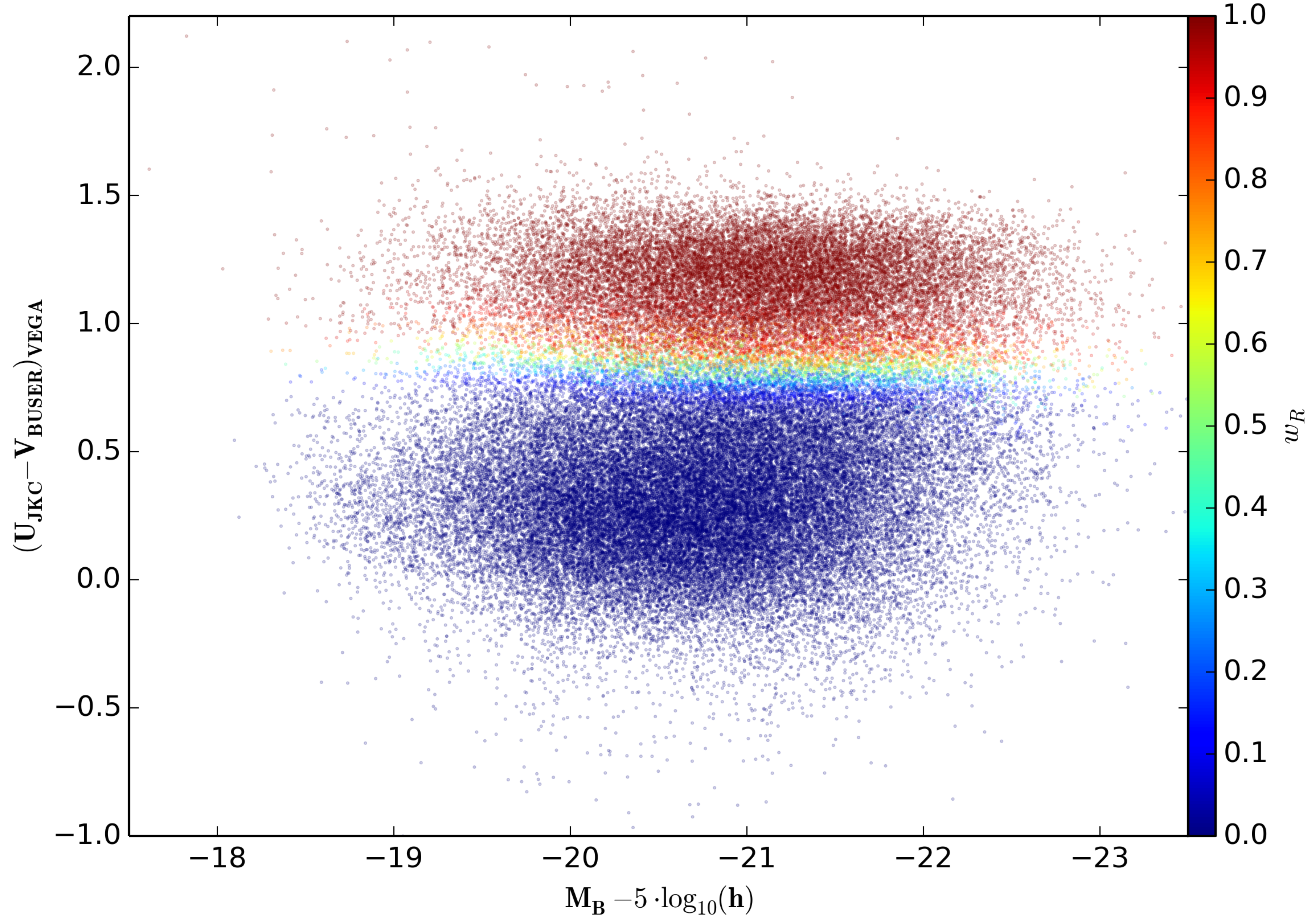
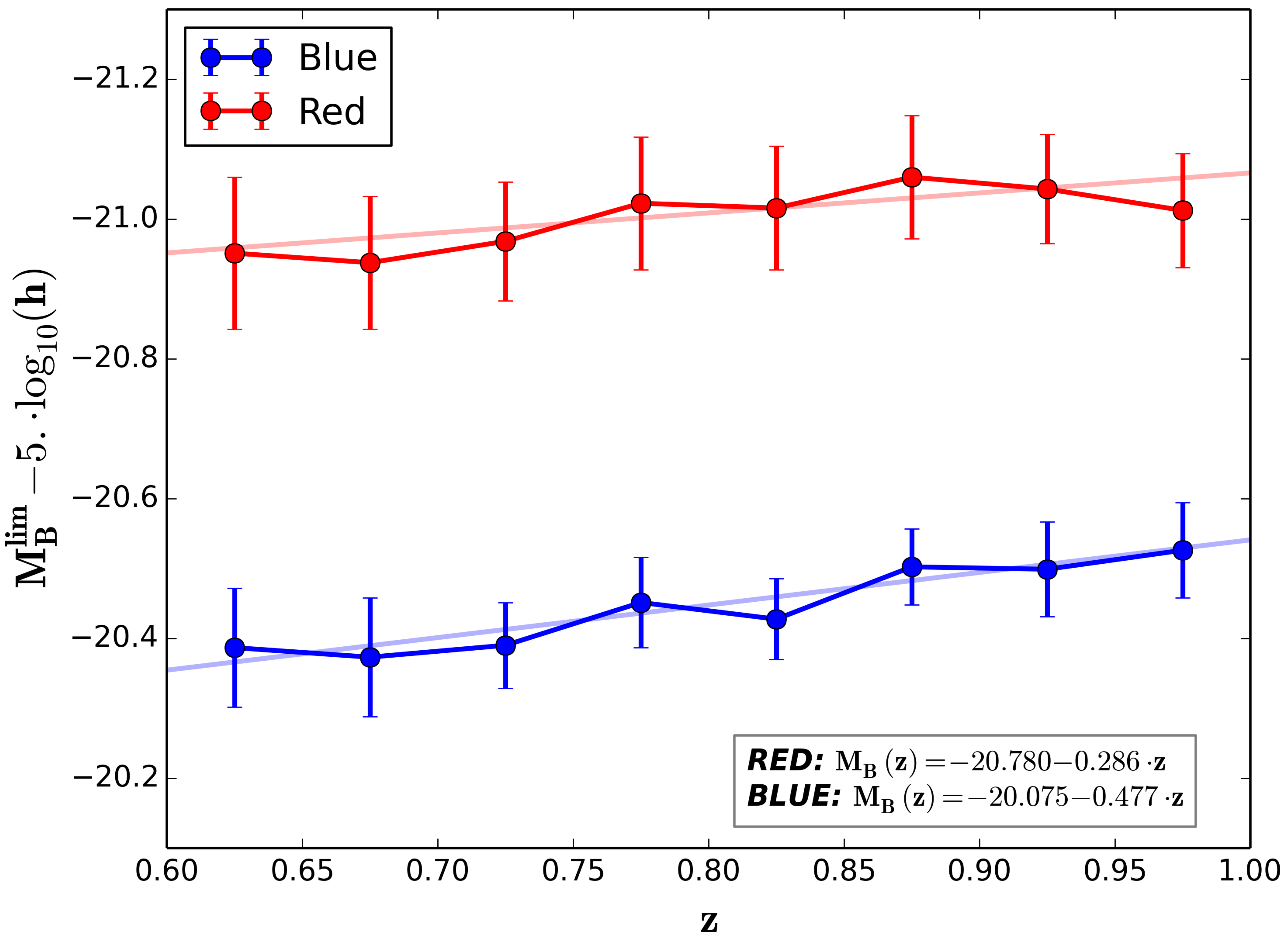


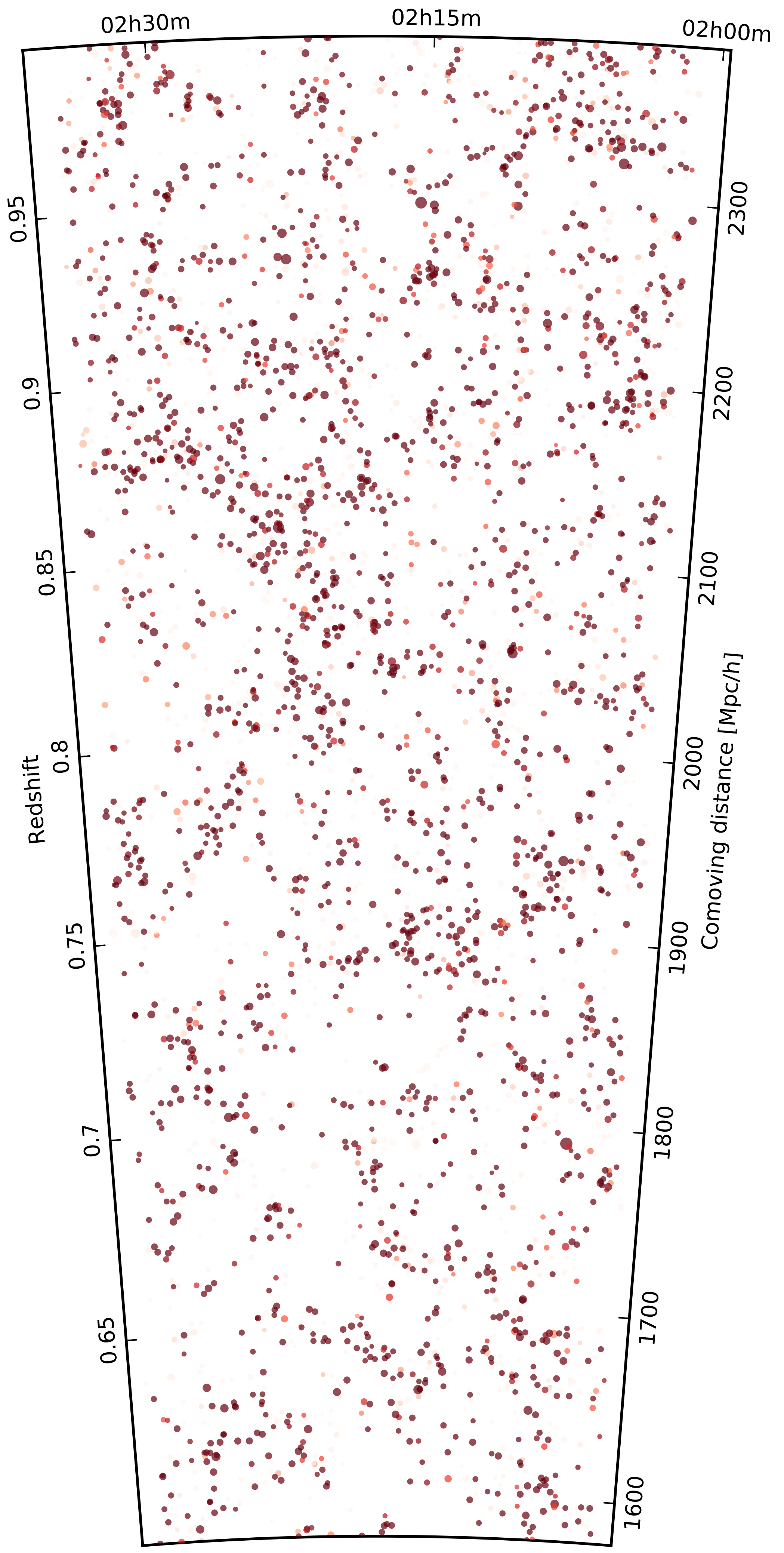
Luminosity Evolution

$$M_B(z) = M_B(z=0) + \mathcal{A} \cdot z$$

- Assume **rare mergers**;
- Constant comoving number density;
- **Linear evolution** (in M_B);



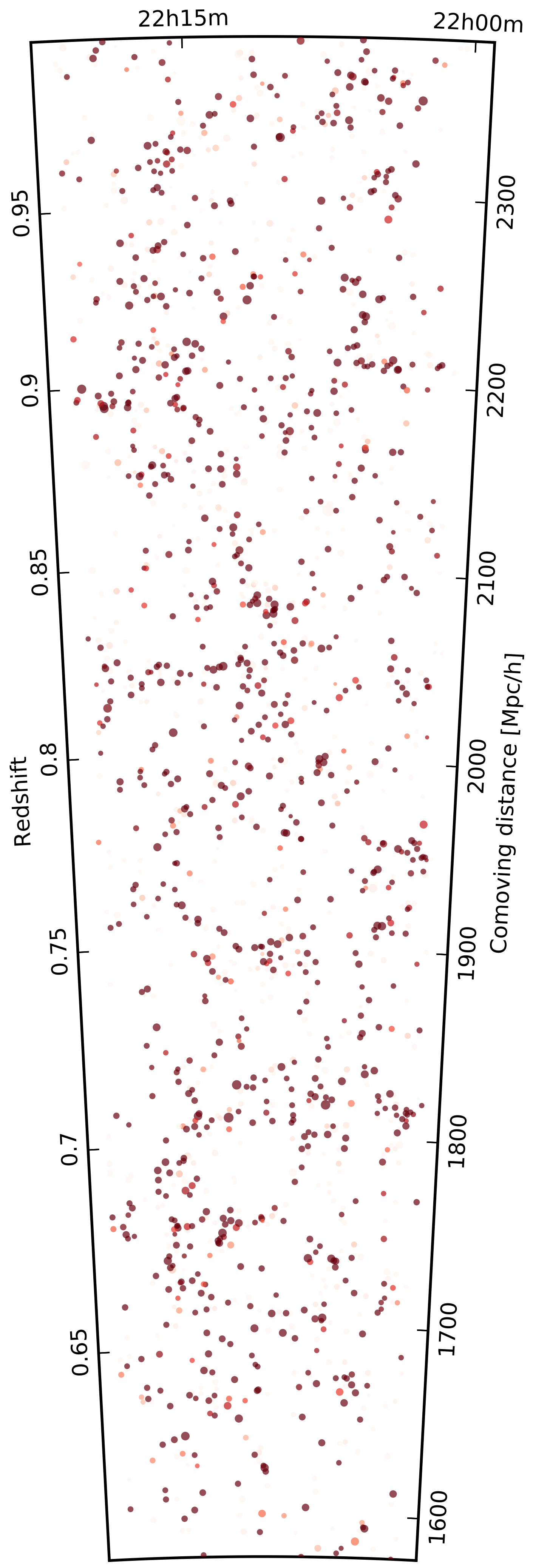
VOLUME LIMITED CATALOGS



W1

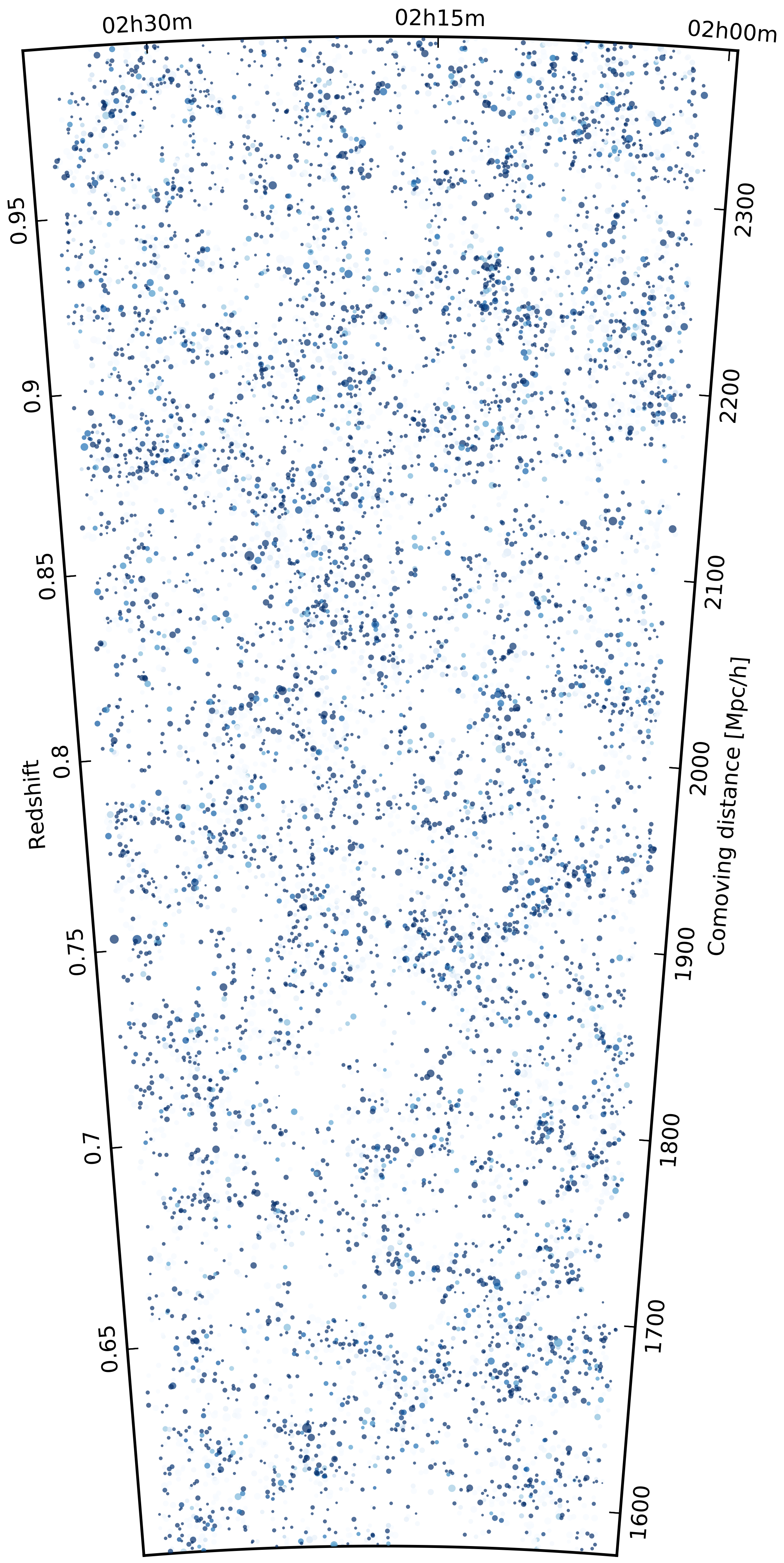
Redshift range: $0.6<z<1.0$ ($z_{eff}\sim 0.83$)

~5,000 luminous red galaxies



W4

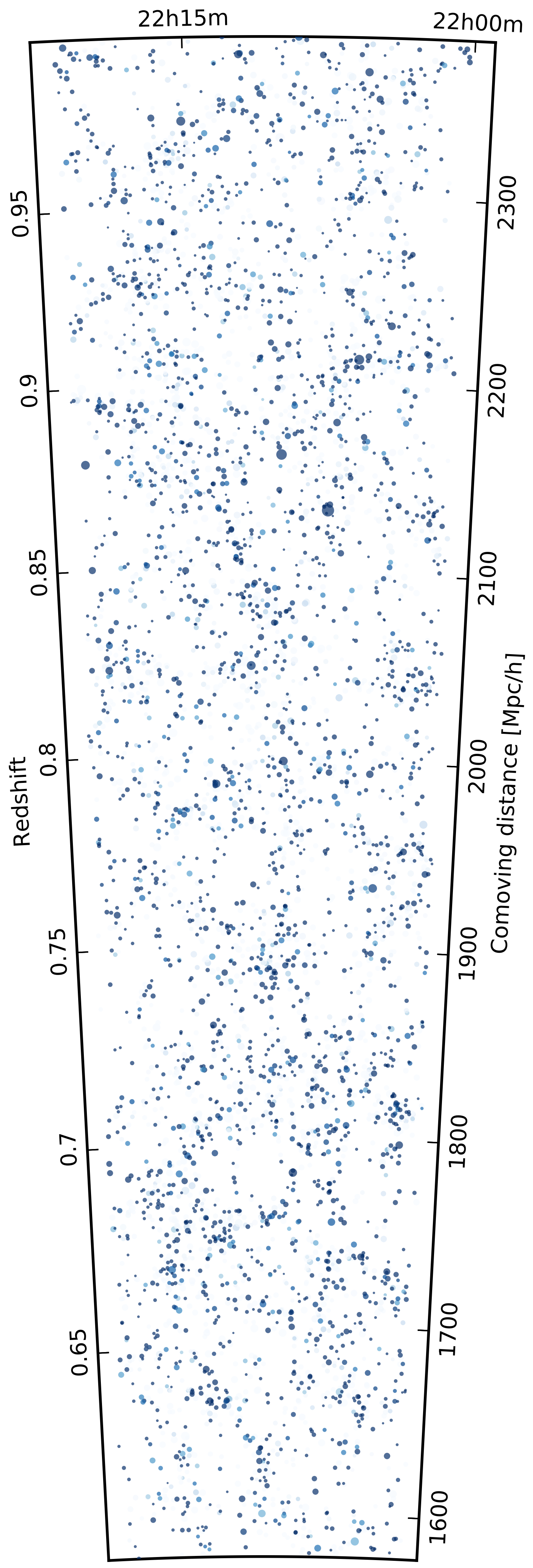
Volume Limited Catalogs



W1

Redshift range: $0.6<z<1.0$ ($z_{eff} \sim 0.83$)

~17,000 blue galaxies



W4

Covariance Matrices

- 306 HOD VIPERS mocks from BigMDPL by Sylvain de la Torre;
- Hard to reproduce blue/red distributions;
- split Cij into shot-noise and sampling variance

$$C_{ij} = C_{ij}^{\mathrm{SV}} + C_{ij}^{\mathrm{SN}}\delta_{ij}$$

- tune galaxy selection in mocks to match amplitude of 2PCF

$$C_{ij}^{\mathrm{SV}} = f[\xi]$$

- consequence: mismatch of galaxy numbers

Mocks	Data
$<N_{\mathrm{blue}}> \sim 11.300$	$N_{\mathrm{blue}} = 16.745$
$<N_{\mathrm{red}}> \sim 2.700$	$N_{\mathrm{red}} = 5.550$

- Remove mock shot noise;
- Add data shot noise;

$$C_{ij}^{\mathrm{data}} = C_{ij} - [C_{ij}^{\mathrm{SN}}\delta_{ij}]_{mocks} + [C_{ij}^{\mathrm{SN}}\delta_{ij}]_{data}$$

Modelling RSD in Cross-Correlation

- Generalize the RSD model to cross-correlation in redshift space (Mountrichas et al. 2009, Blake et al. 2013);

$$P^s_{cr}(\mathbf{k},z) = [b_{blue}(z)\sigma_8(z)+f(z)\sigma_8(z)\mu_k^2][b_{red}(z)\sigma_8(z)+f(z)\sigma_8(z)\mu_k^2]P_m(k,z)\frac{1}{1+(k\mu_k\sigma_{12})^2}$$

- Fits to the monopole and quadrupole of 2PCF;

$$P^{s,(\ell)}(k,z) = \frac{2\ell+1}{2}\int_{-1}^{+1} P^s(k,\mu_k,z)L_\ell(\mu_k)d\mu_k$$

$$\xi^{s,(\ell)}(s) = i^\ell \int \frac{k^2 dk}{2\pi^2} P^{s,(\ell)}(k) j_\ell(ks)$$

- Truncated multipoles **(arXiv:1502.05045)**:

$$\hat{\xi}^{s,(\ell)}(s) = \frac{2\ell+1}{2}\int_{-\bar{\mu}}^{+\bar{\mu}} \xi^s(s,\mu)L_\ell(\mu)d\mu$$

$$\bar{\mu} = \sqrt{1+\left(\frac{\bar{r}_p}{s}\right)^2}$$

See Andrea Pezzotta's poster.

Modelling RSD in Cross-Correlation

• Generalize the RSD model to cros ... ake et al. 2013);

$$P^s_{cr}(\mathbf{k}, z) = [b_{blue}(z)\sigma_8 \quad \ldots \quad P_m(k,z)\frac{1}{1+(k\mu_k\sigma_{12})^2}$$

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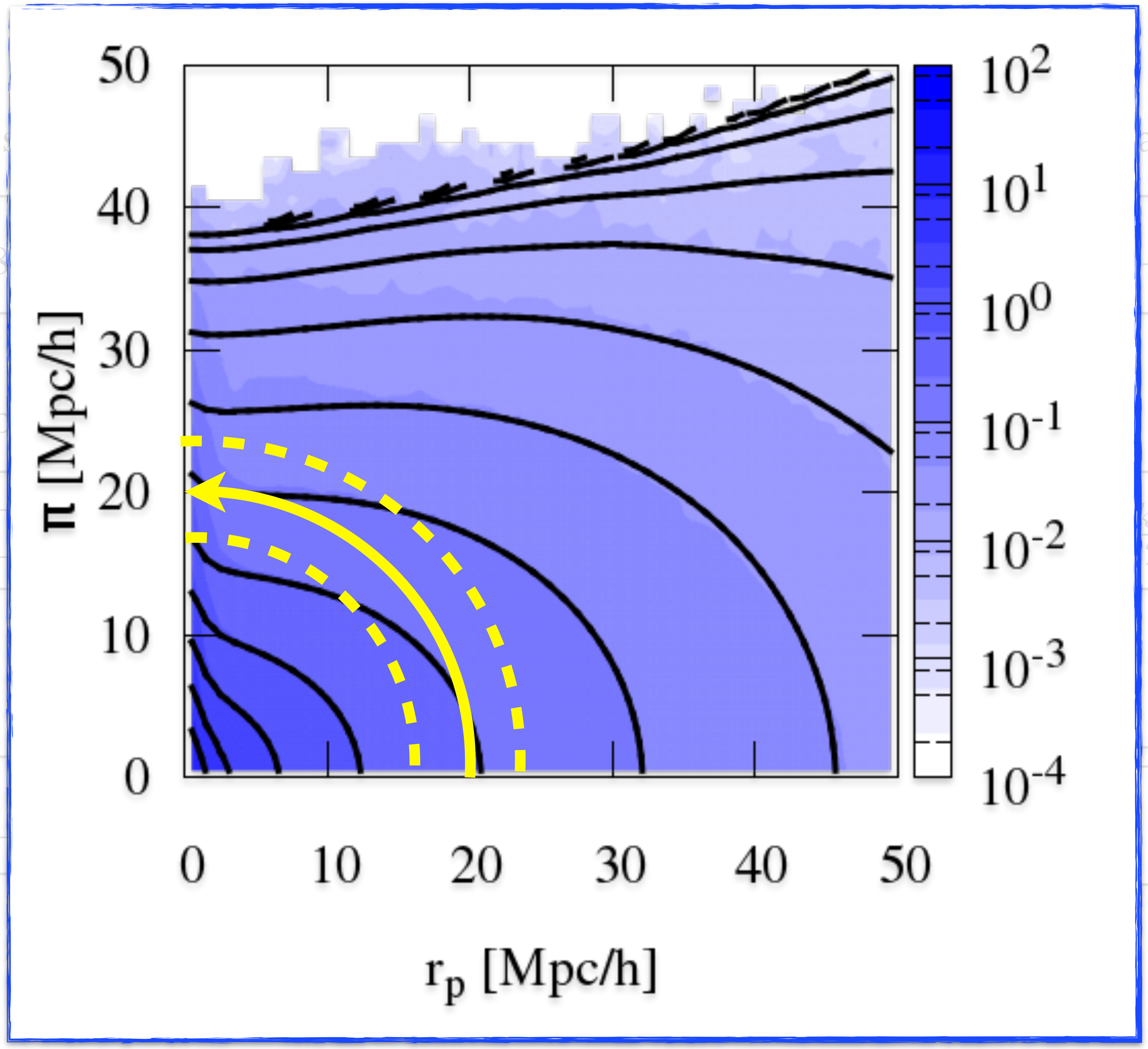
$$P^{s,(\ell)}(k,z) = \frac{2\ell+1}{2}\int \quad \ldots \quad \frac{k^2 dk}{2\pi^2} P^{s,(\ell)}(k) j_\ell(ks)$$

• Truncated multipoles

$$\hat{\xi}^{s,(\ell)}(s) = \frac{2\ell+1}{2}\int \quad \ldots \quad + \left(\frac{r_p}{s}\right)^2$$



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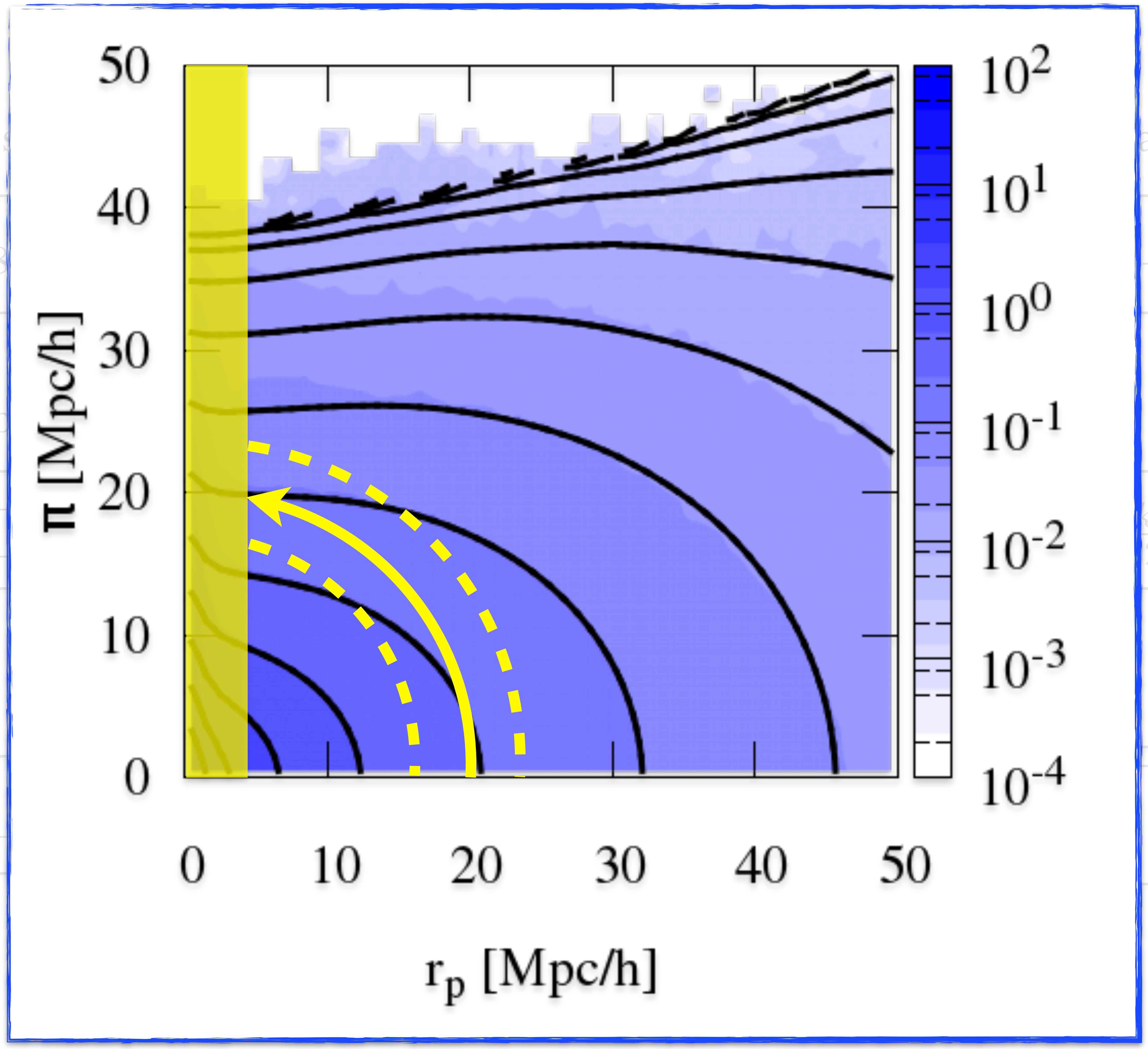

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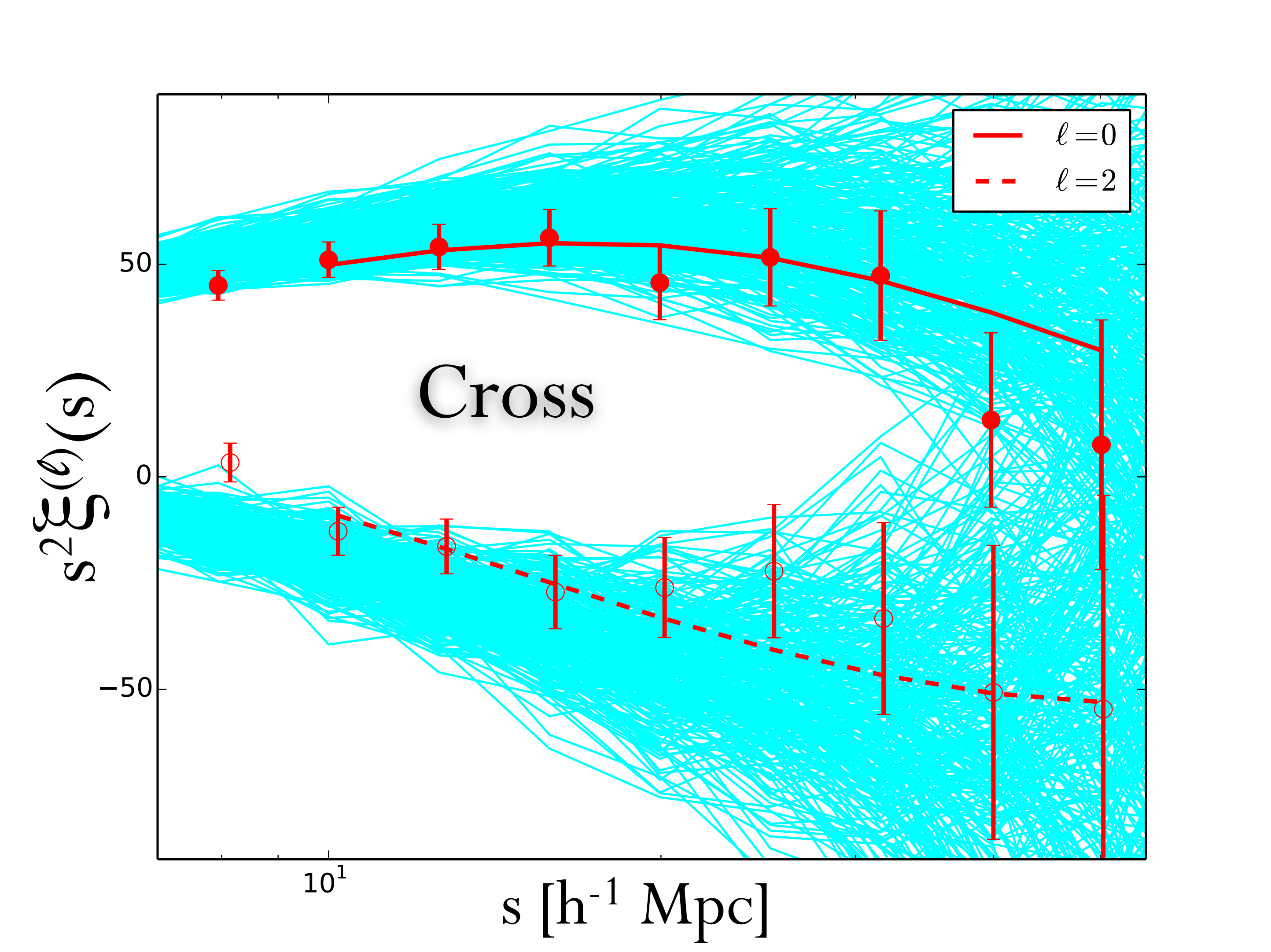
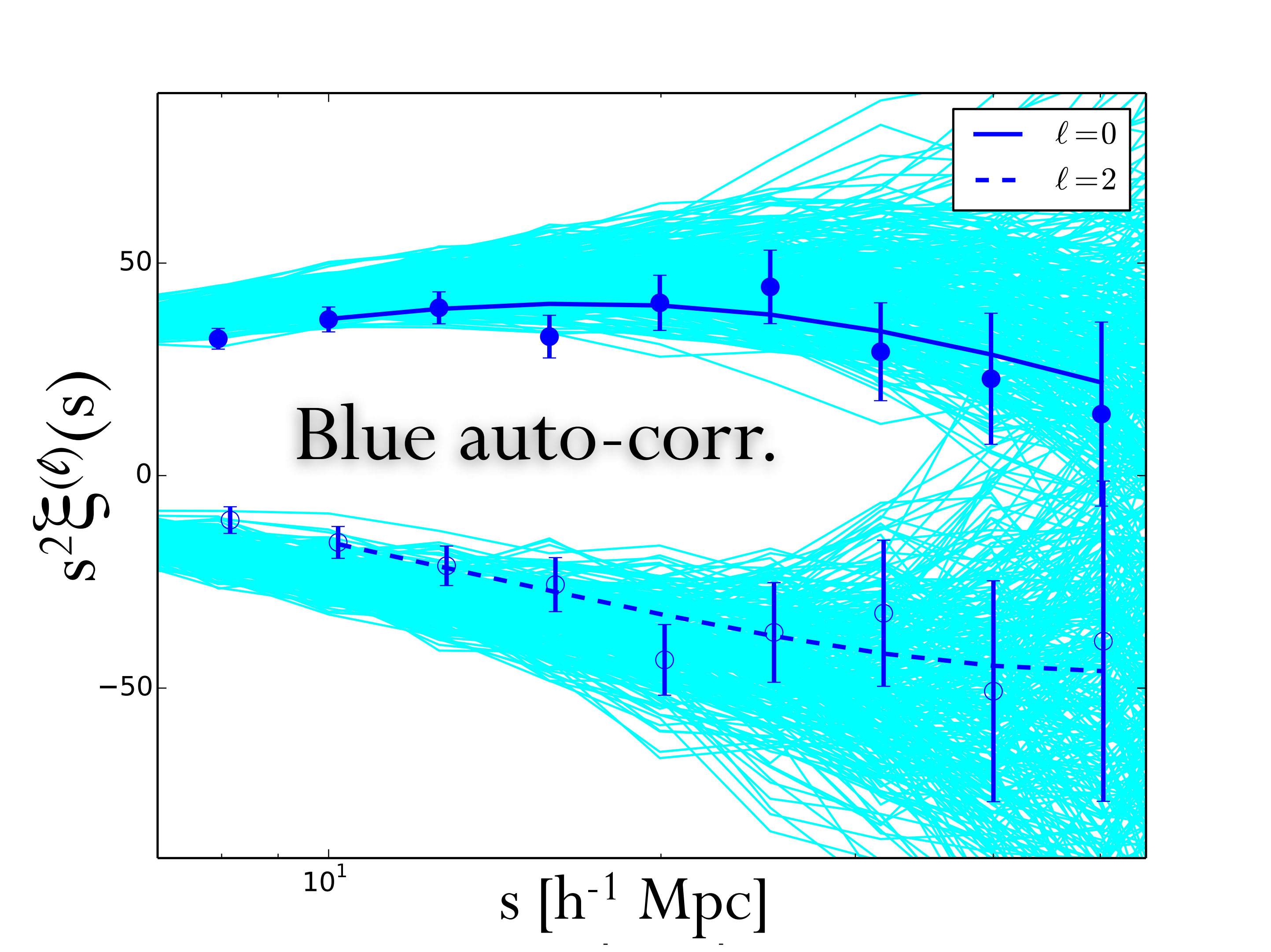
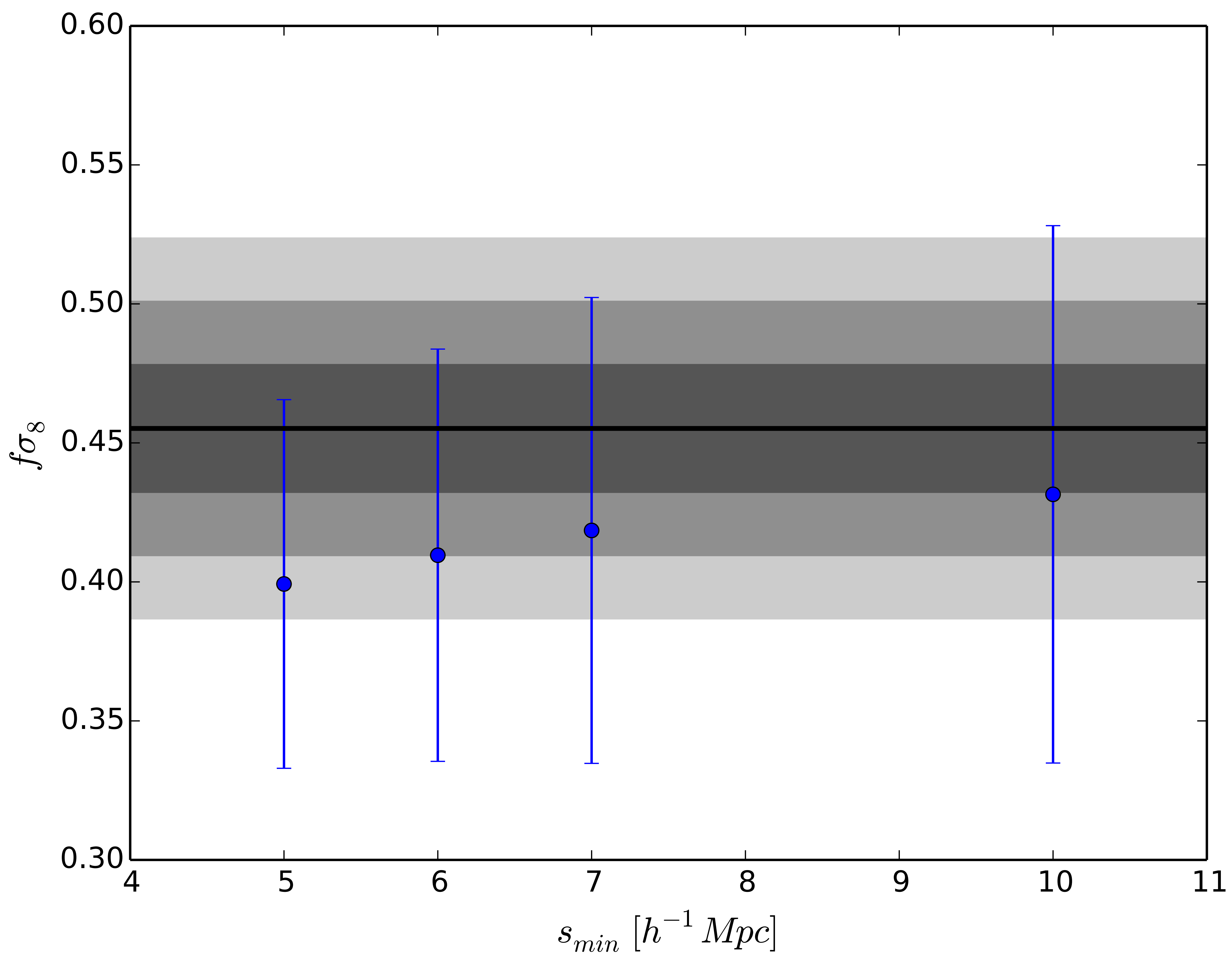
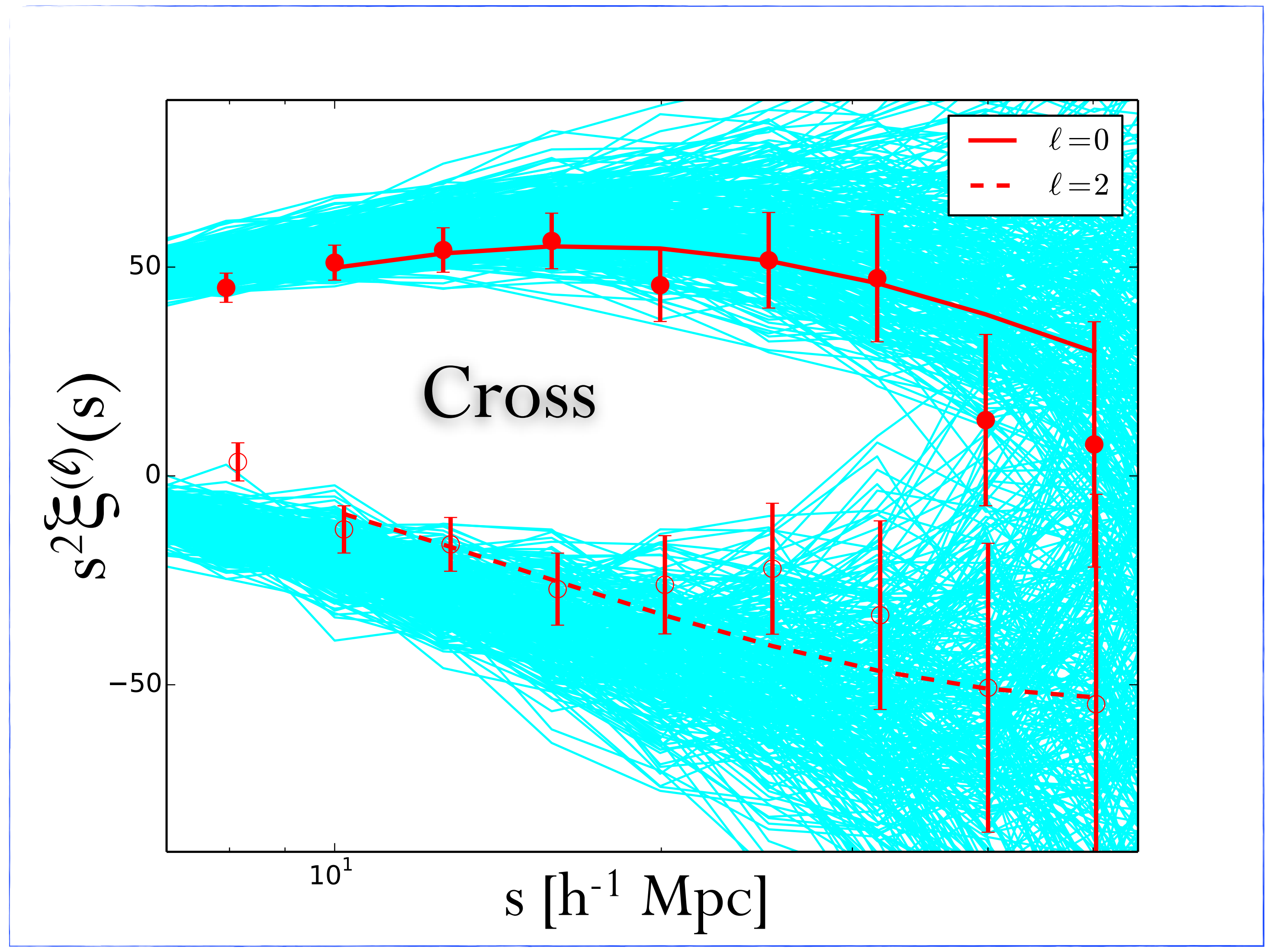
Model Testing

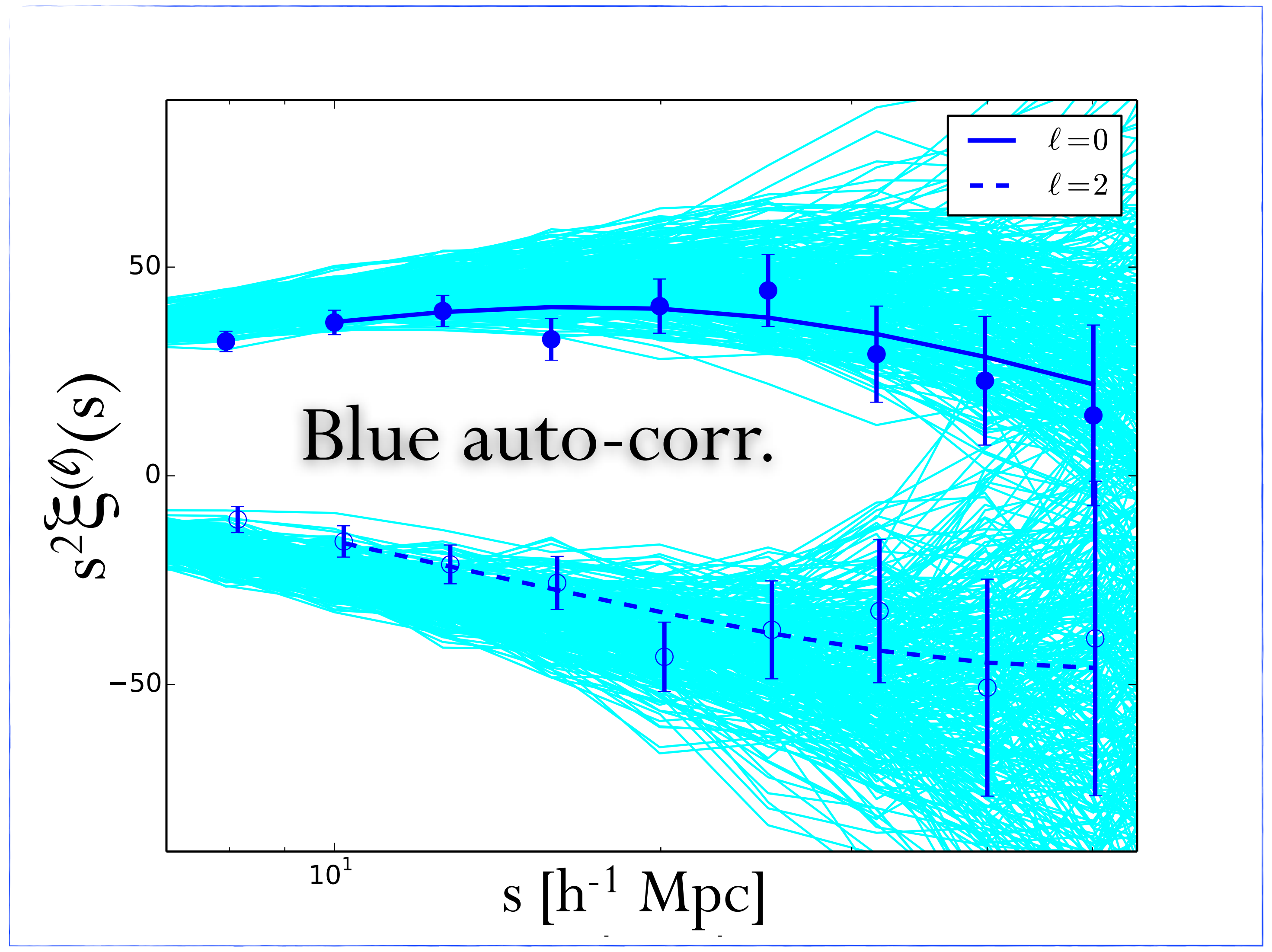






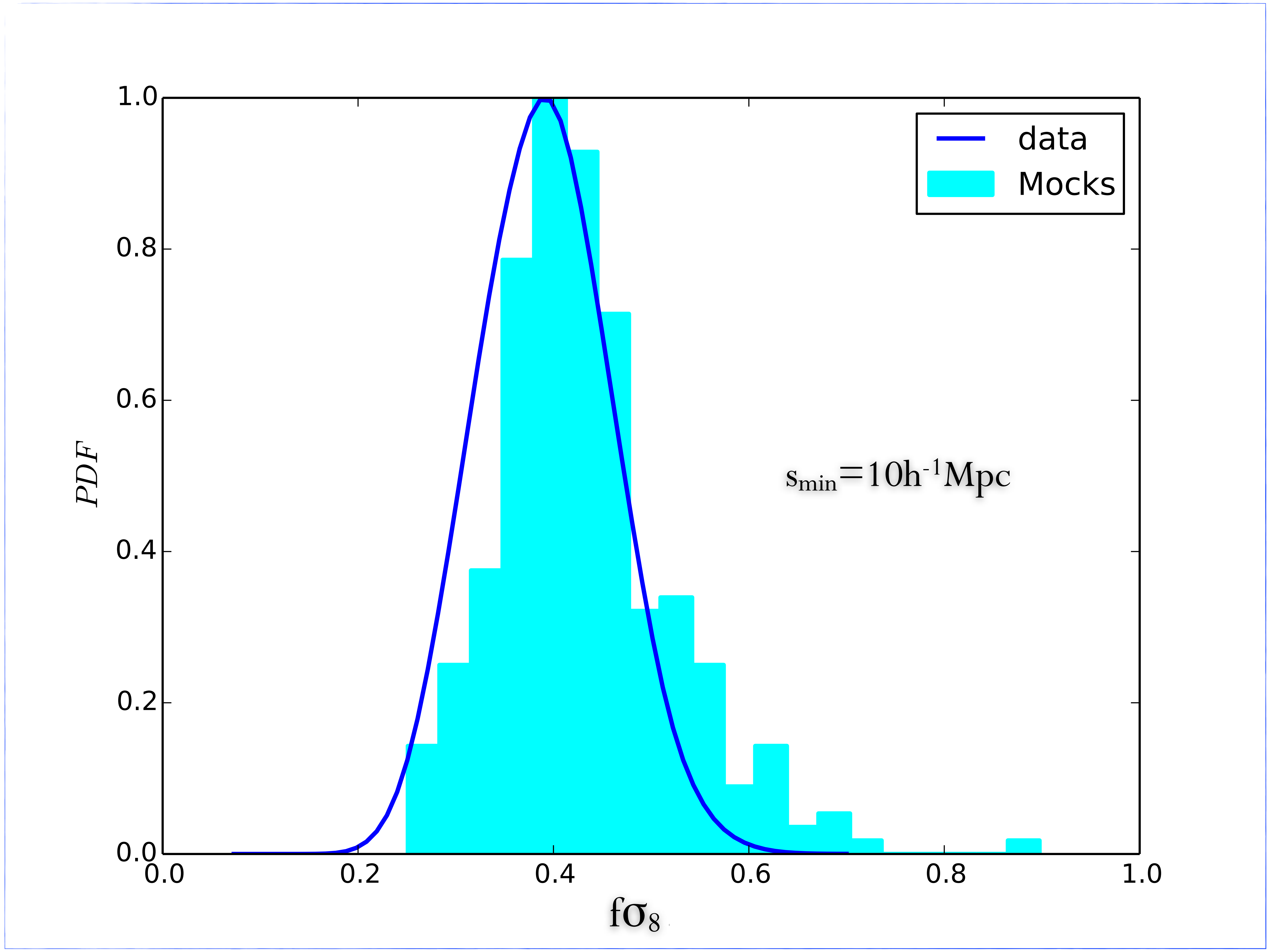
First Results From VIPERS Full Sample





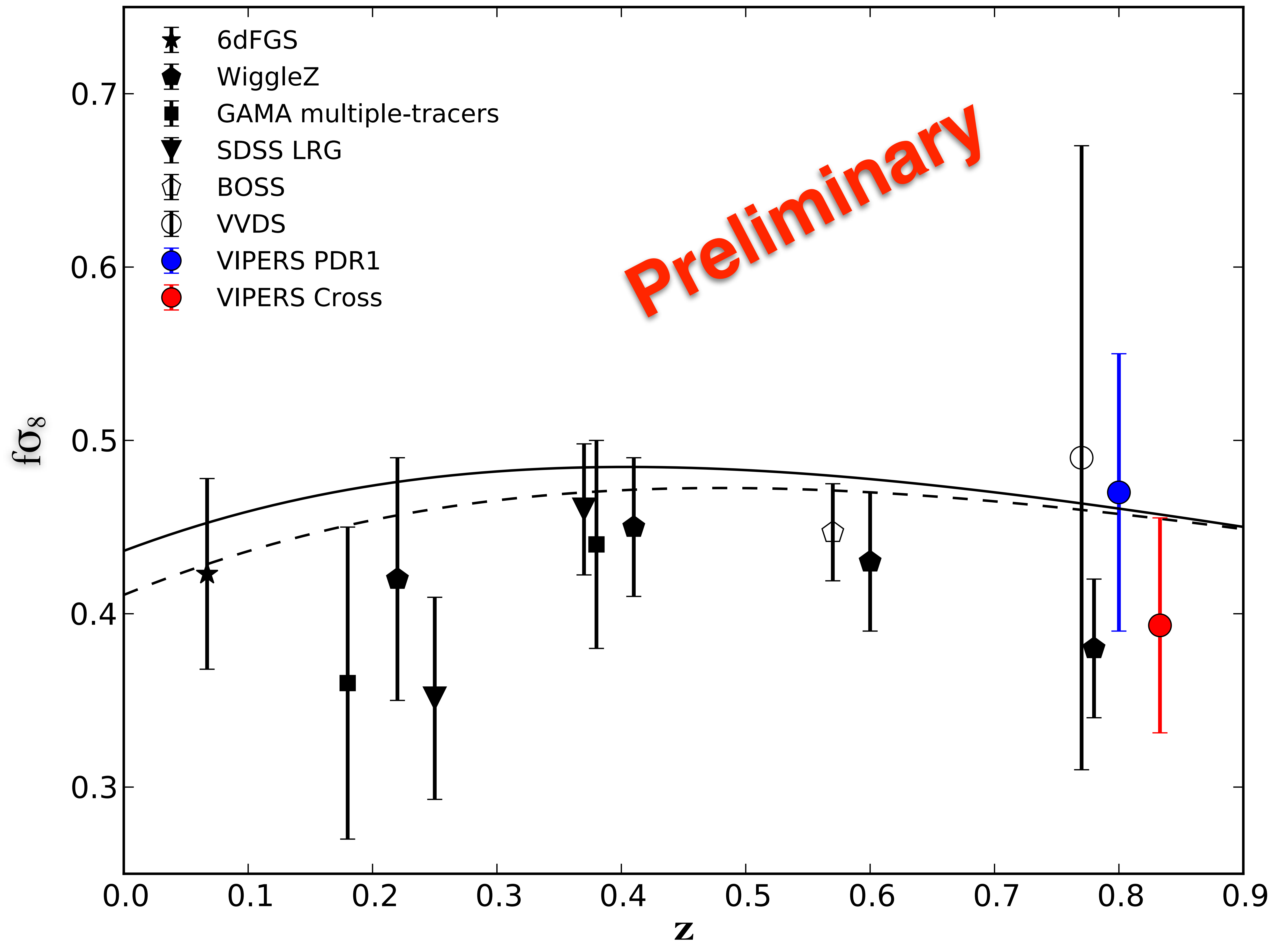
$b_{red}/b_{blue} \simeq 1.45$

$f\sigma_8(z=0.83) = 0.39 \pm 0.07$



Results

$$f\sigma_8(z{=}0.83) = 0.39 \pm 0.07$$



Summary

- First application of the multi-tracer analysis to VIPERS final data release;

- Preliminary estimate of $f\sigma_8$ at z_{eff}~0.83

- Future plans:
    1. compare statistical errors between single and multiple tracers (McDonald & Seljak 2009),
    2. group-galaxy cross-corr. application to VIPERS (Mohammad et. al. 2015),
    3. use truncated multipole moments,
    4. combine with more sophisticated RSD models.

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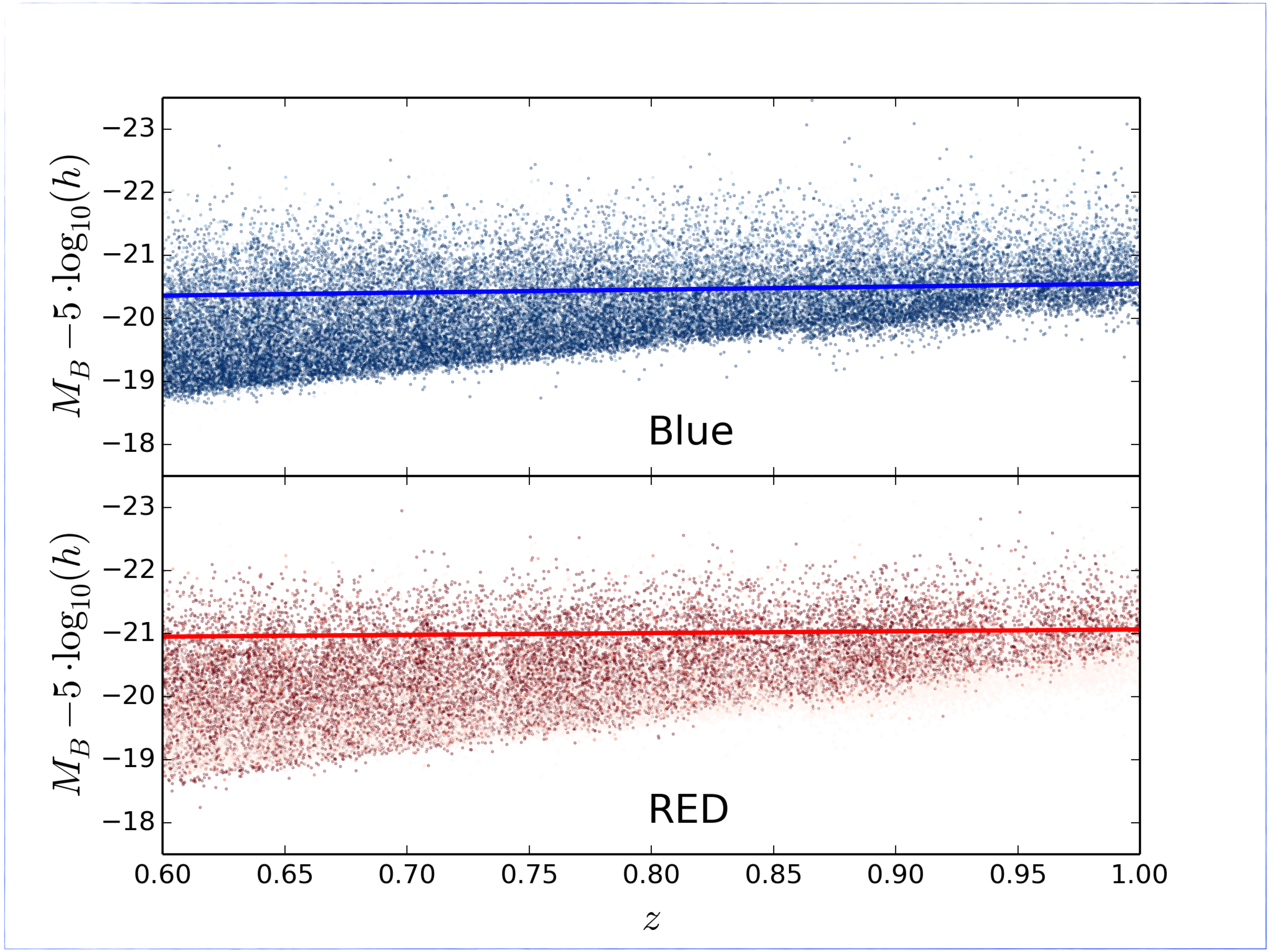

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