Clustering tomography on the final BOSS DR12 galaxy sample

Salvador Salazar-Albornoz
(Project B14)

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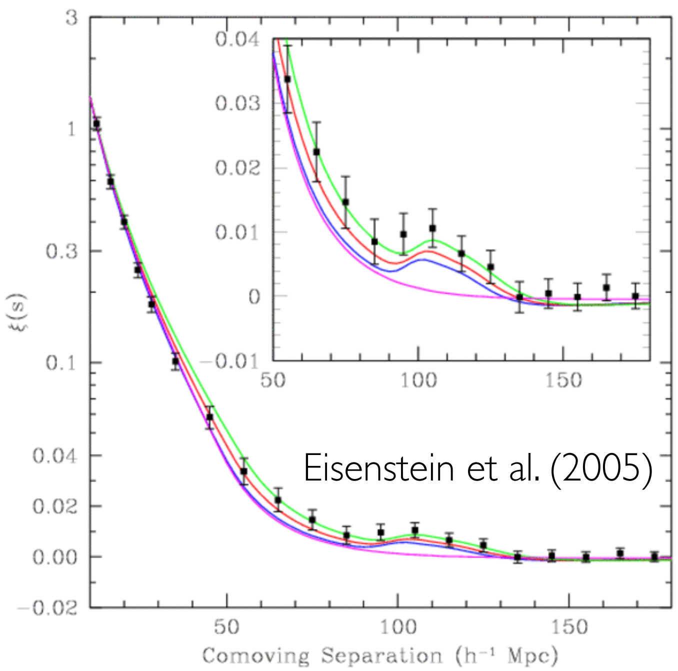
Corfu, September 14th 2015

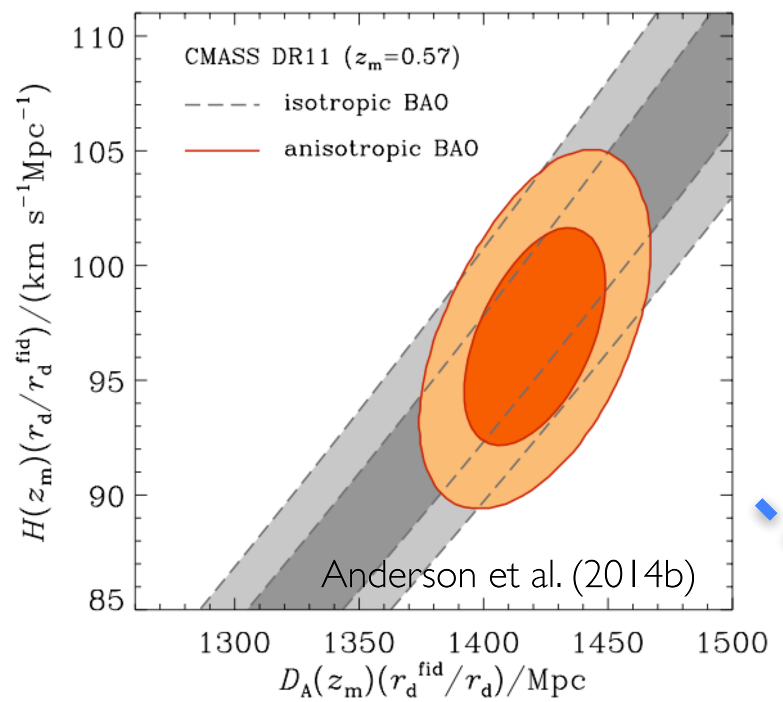
OUTLINE

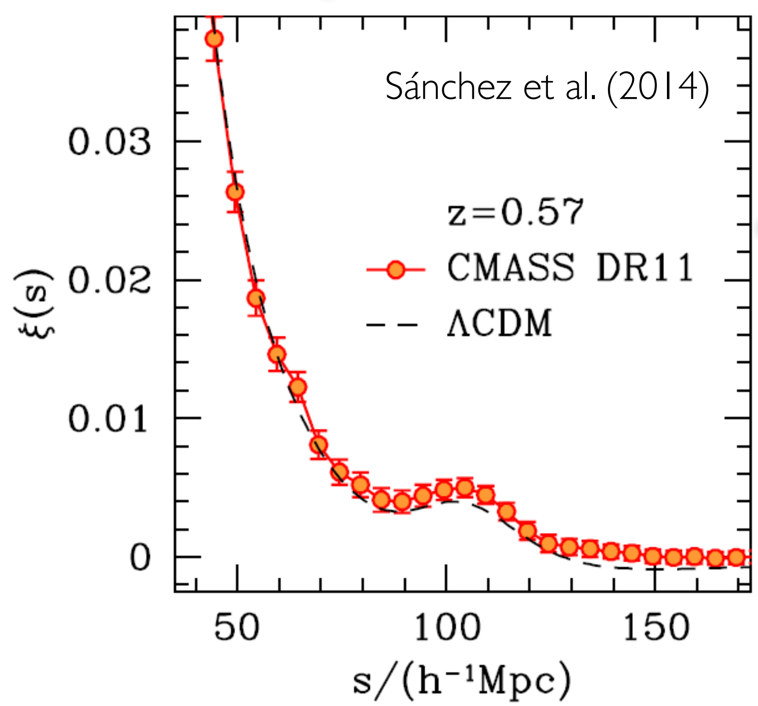
- Introduction.
- Clustering Tomography.
- Update on the clustering tomography on BOSS-DR12 galaxy sample.
- Summary.

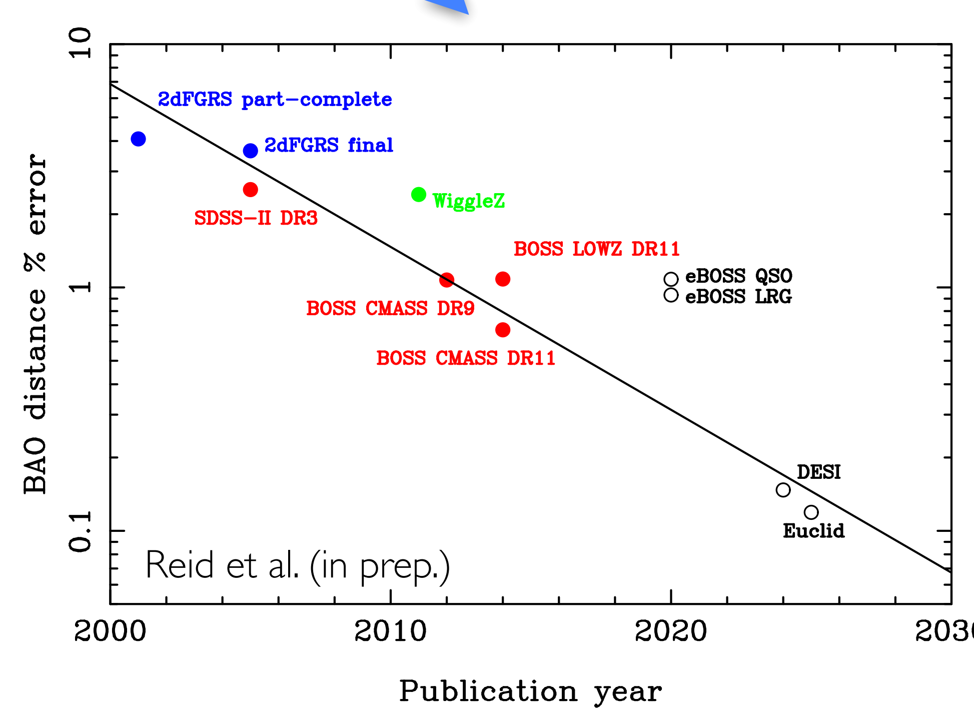
INTRODUCTION

BAO are a great tool for observational cosmology.









INTRODUCTION

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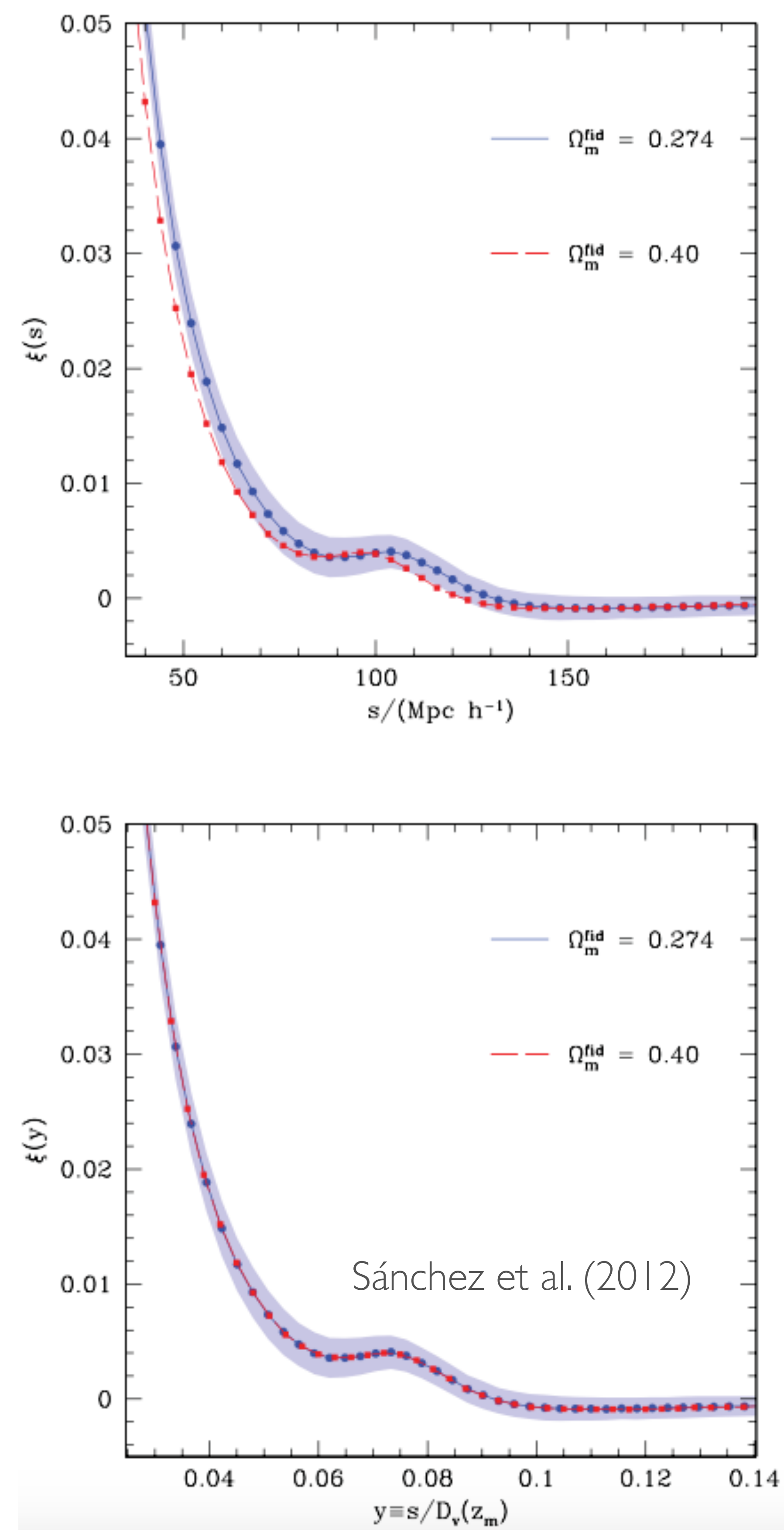
- Requires the assumption of a **fiducial cosmology** to transform RA, DEC, z into physical distances.



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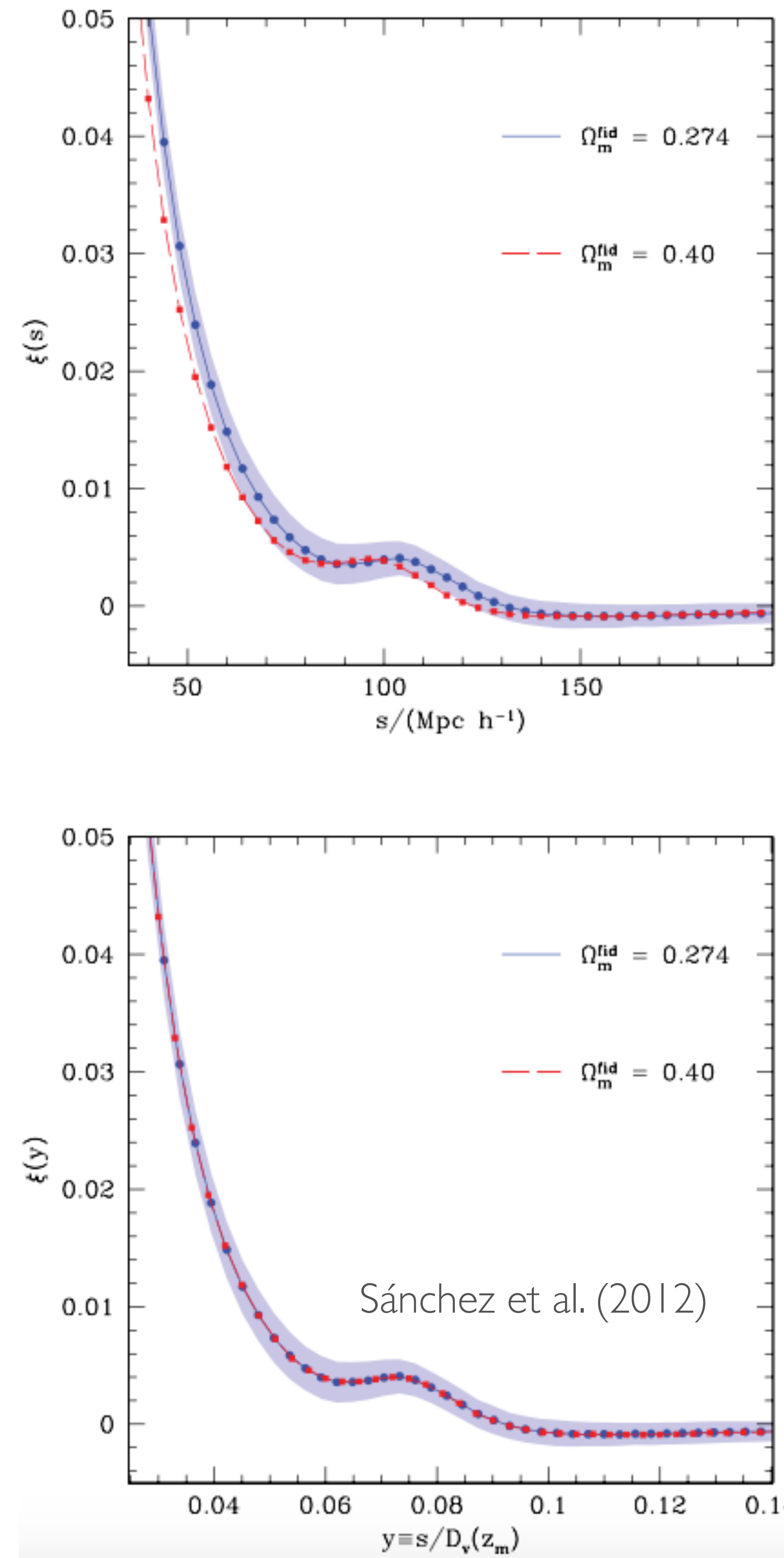
- **Averages** the signal over large cosmological volumes, **ignoring light-cone effects**.



INTRODUCTION

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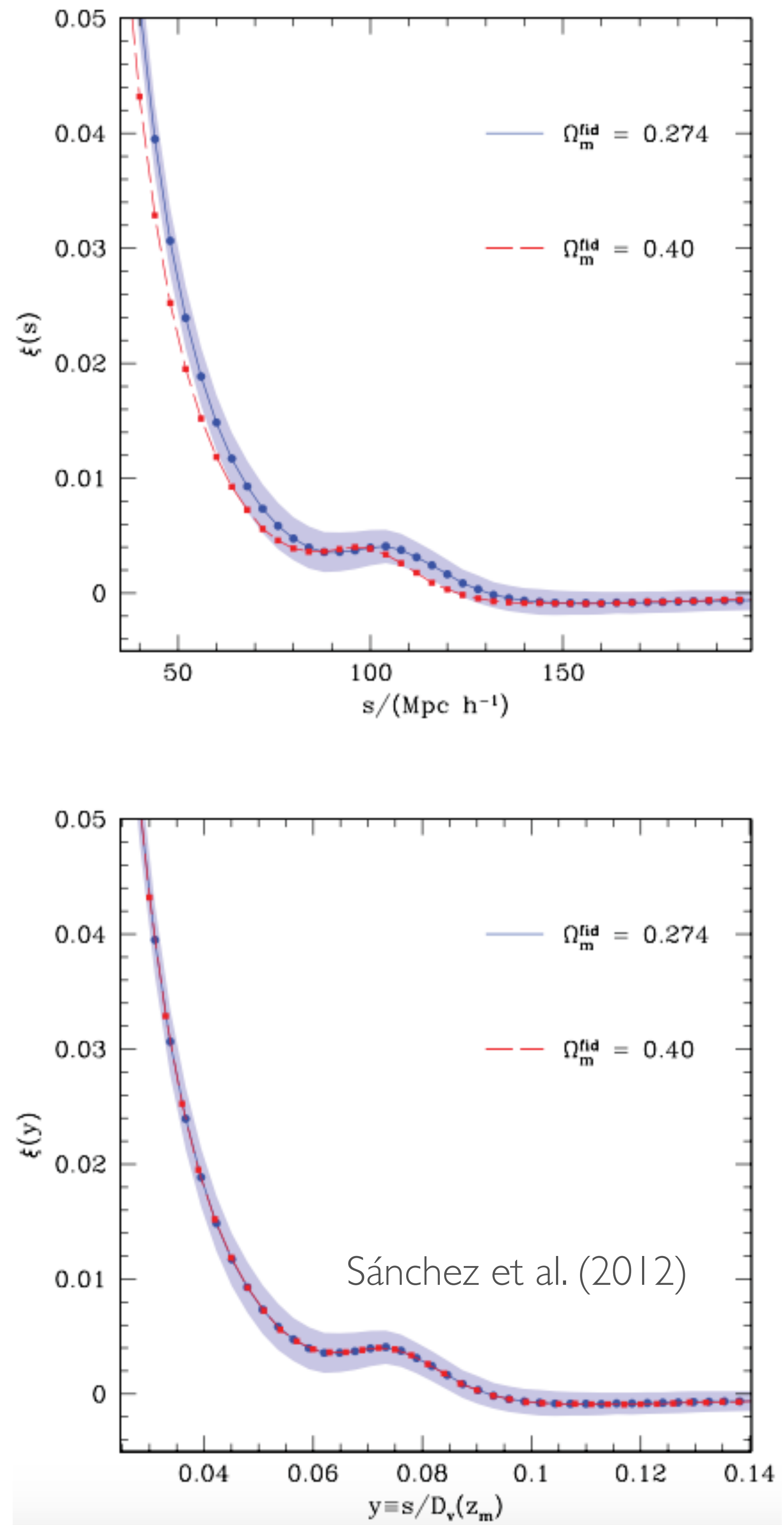
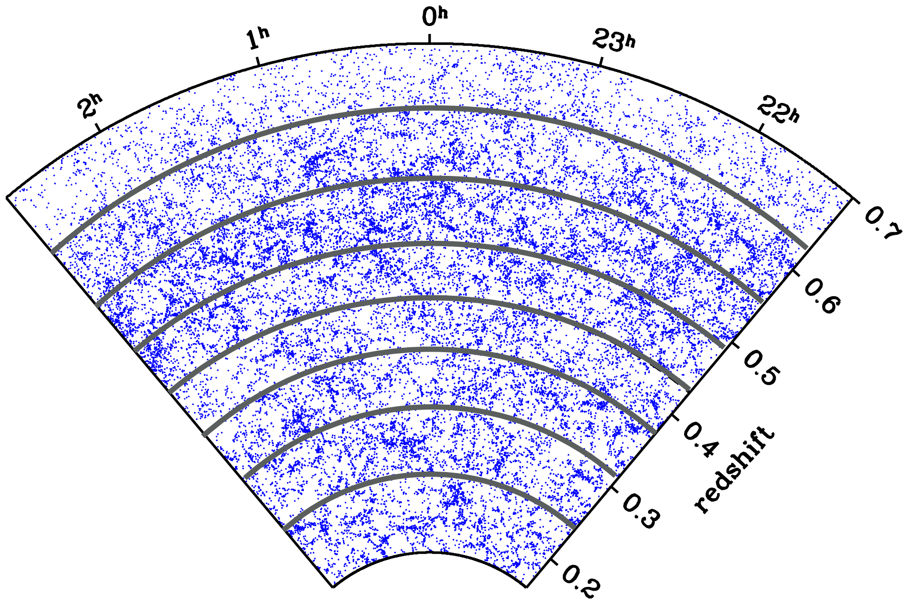
- **Averages** the signal over large cosmological volumes, **ignoring light-cone effects**.
- Gives **only one distance** measurement for a large redshift range.



INTRODUCTION

A way to avoid these assumptions is to use **angular clustering** measurements (see e.g. Crocce et al. 2011b, Ross et al. 2011, Asorey et al. 2012, Di Dio et al. 2014, Salazar-Albornoz et al. 2014).



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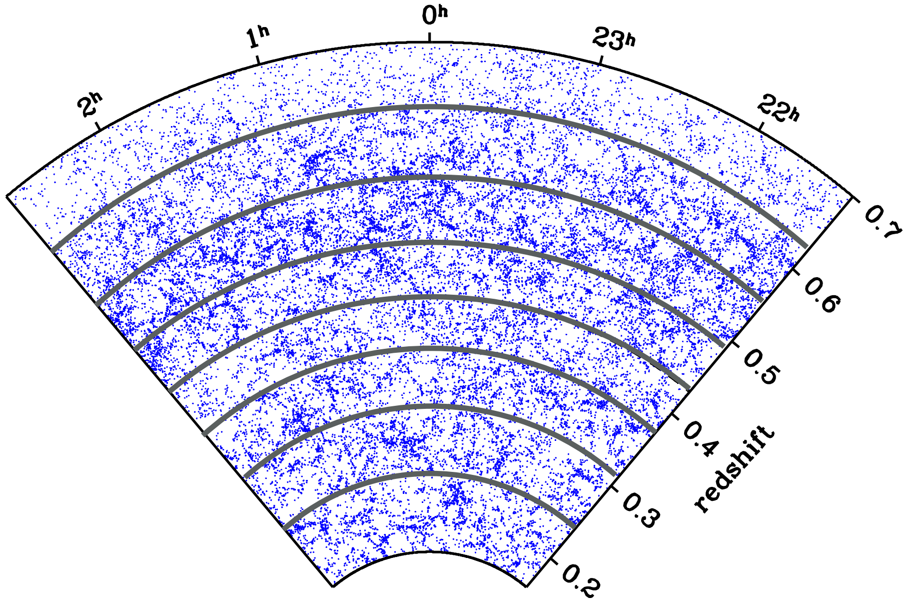

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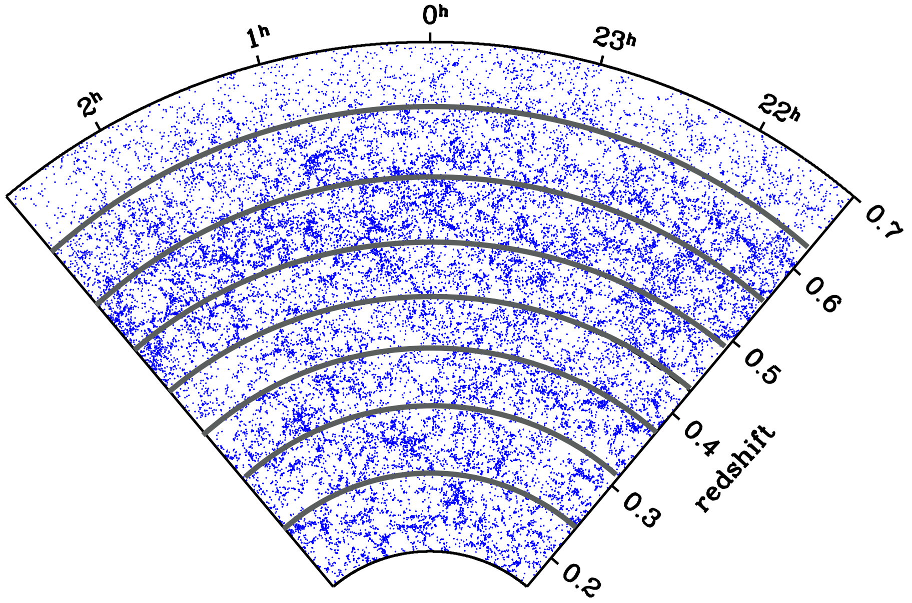
- ☑ **Cosmology independent** measurements.
- ☑ Requires division in redshift bins (shells), **allowing** the study of **light-cone effects**.



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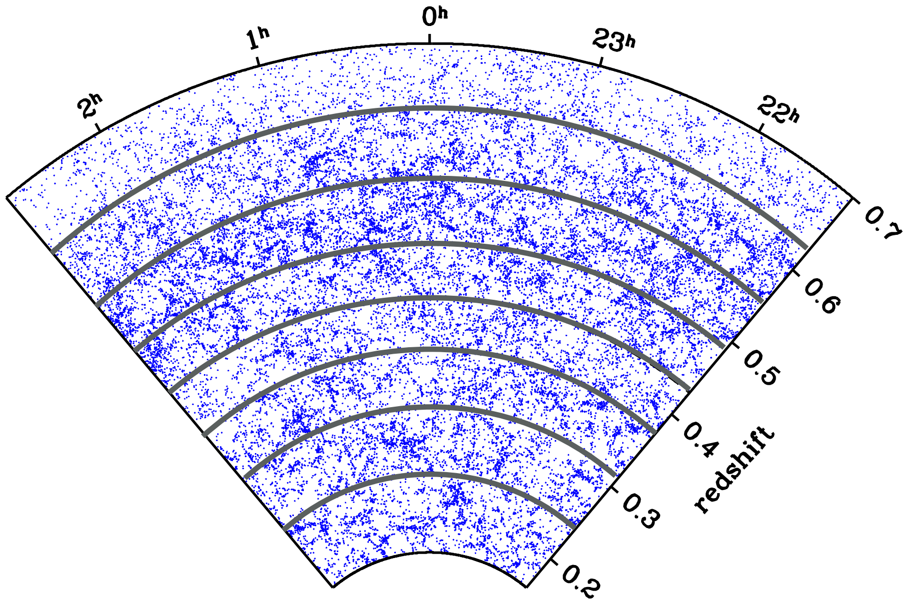
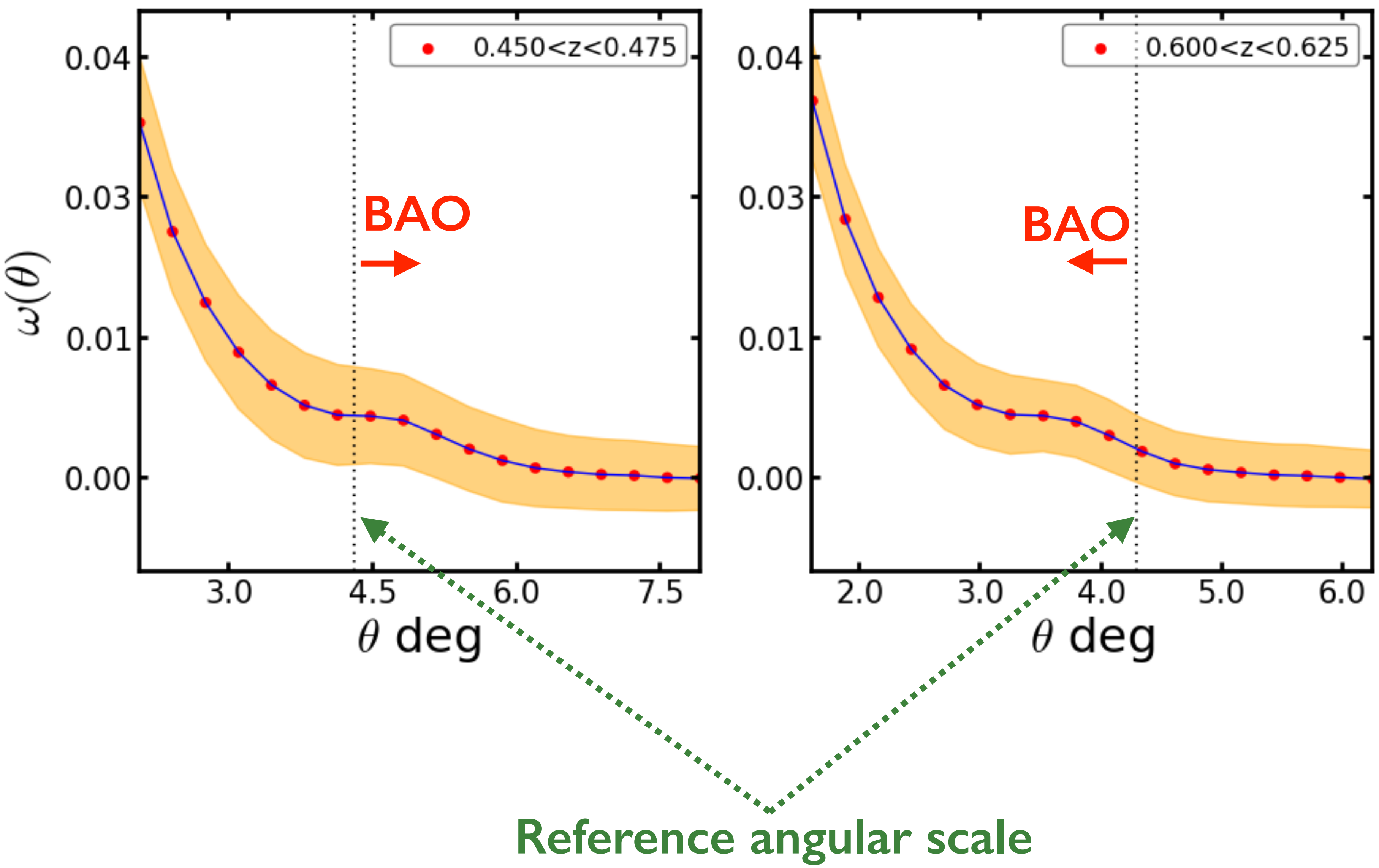
- ☑ **Cosmology independent** measurements.
- ☑ Requires division in redshift bins (shells), **allowing** the study of **light-cone effects**.
- ☑ Exploits the information of the **$D_M(z)$** evolution.



ANGULAR CORRELATION FUNCTIONS IN REDSHIFT-SHELLS

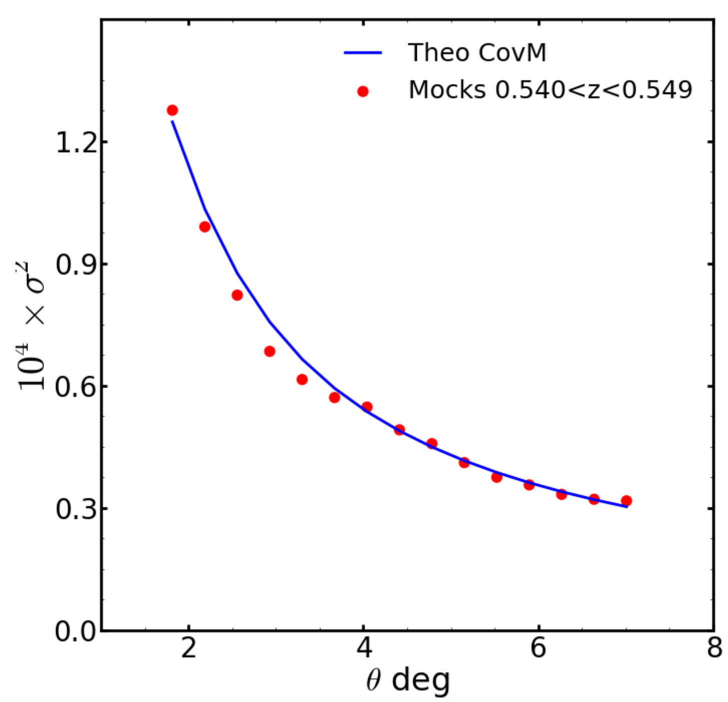


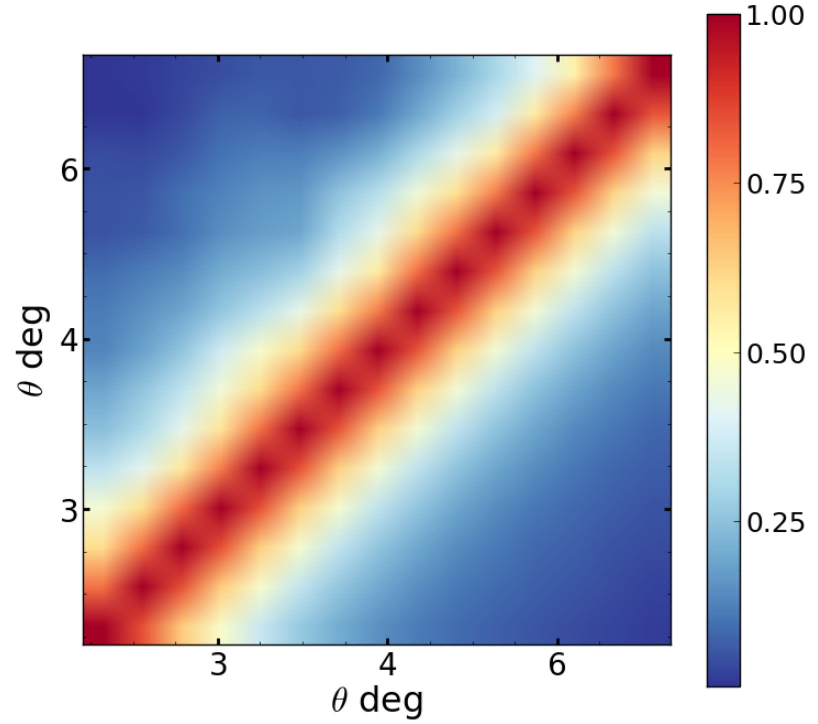
ANGULAR CORRELATION FUNCTIONS IN REDSHIFT-SHELLS

- We extract cosmological information through **full-shape fits**.

$$\omega(\theta) = \int dz_1 \phi(z_1) \int dz_2 \phi(z_2) \xi(z_1, z_2, \theta)$$

- **Large number of mock** catalogs is needed to make a good direct estimate of the covariance matrix. We use an **analytical** form instead.



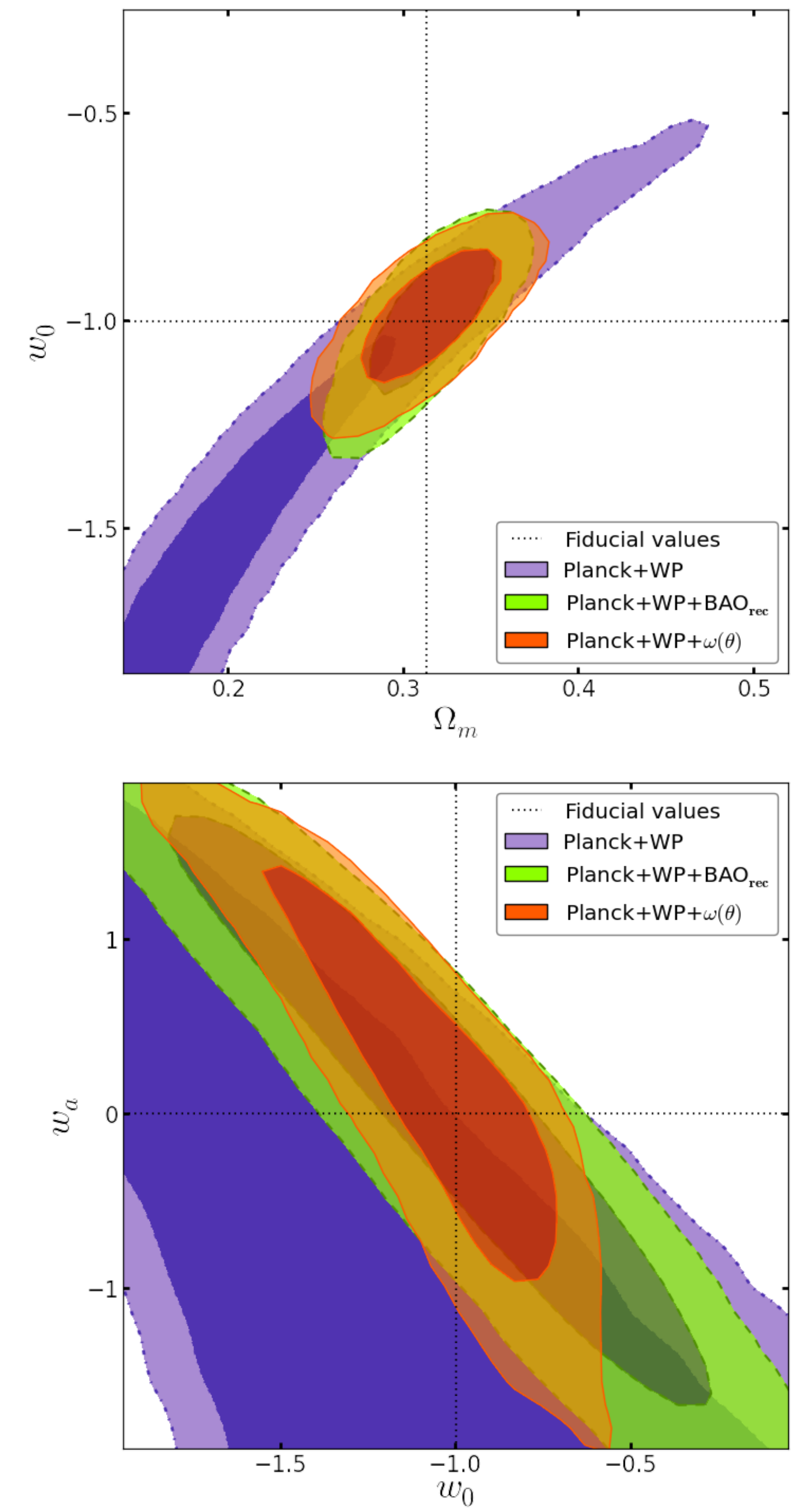


ANGULAR CORRELATION FUNCTIONS IN REDSHIFT-SHELLS

Forecast for BOSS DR12

- Constraints on constant w_{DE} comparable to those of isotropic BAO post-recon.
- **Improved** constraints on time-dependent $w_{\mathrm{DE}}(a)$, parametrized as (Chevallier & Polanski 2001, Linder 2003):

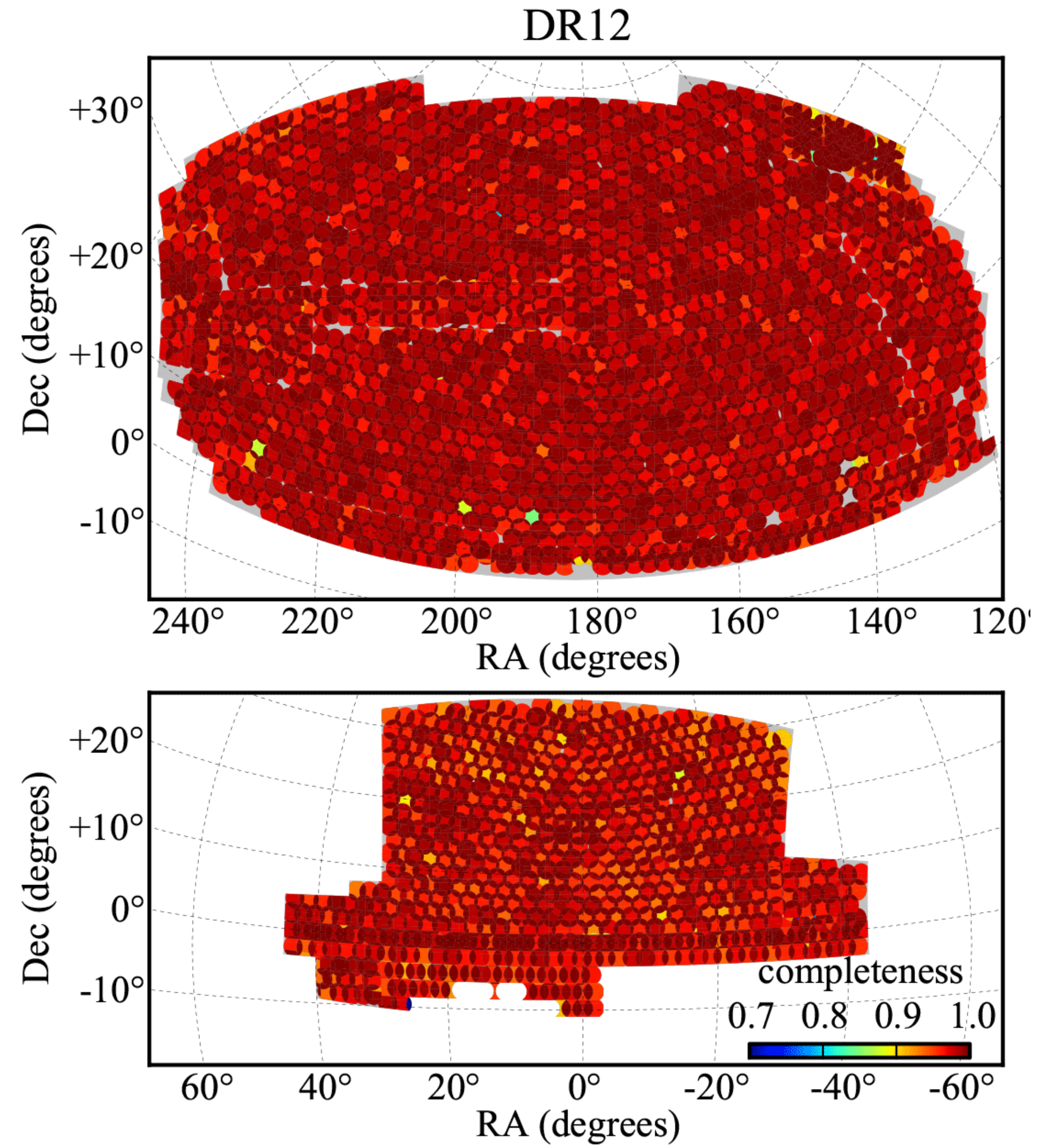
$$w_{\mathrm{DE}}(a) = w_0 + w_{\mathrm{a}}(1 - a)$$



Salazar-Albornoz et al. (2014)

THE BARYON ACOUSTIC OSCILLATION SPECTROSCOPIC SURVEY

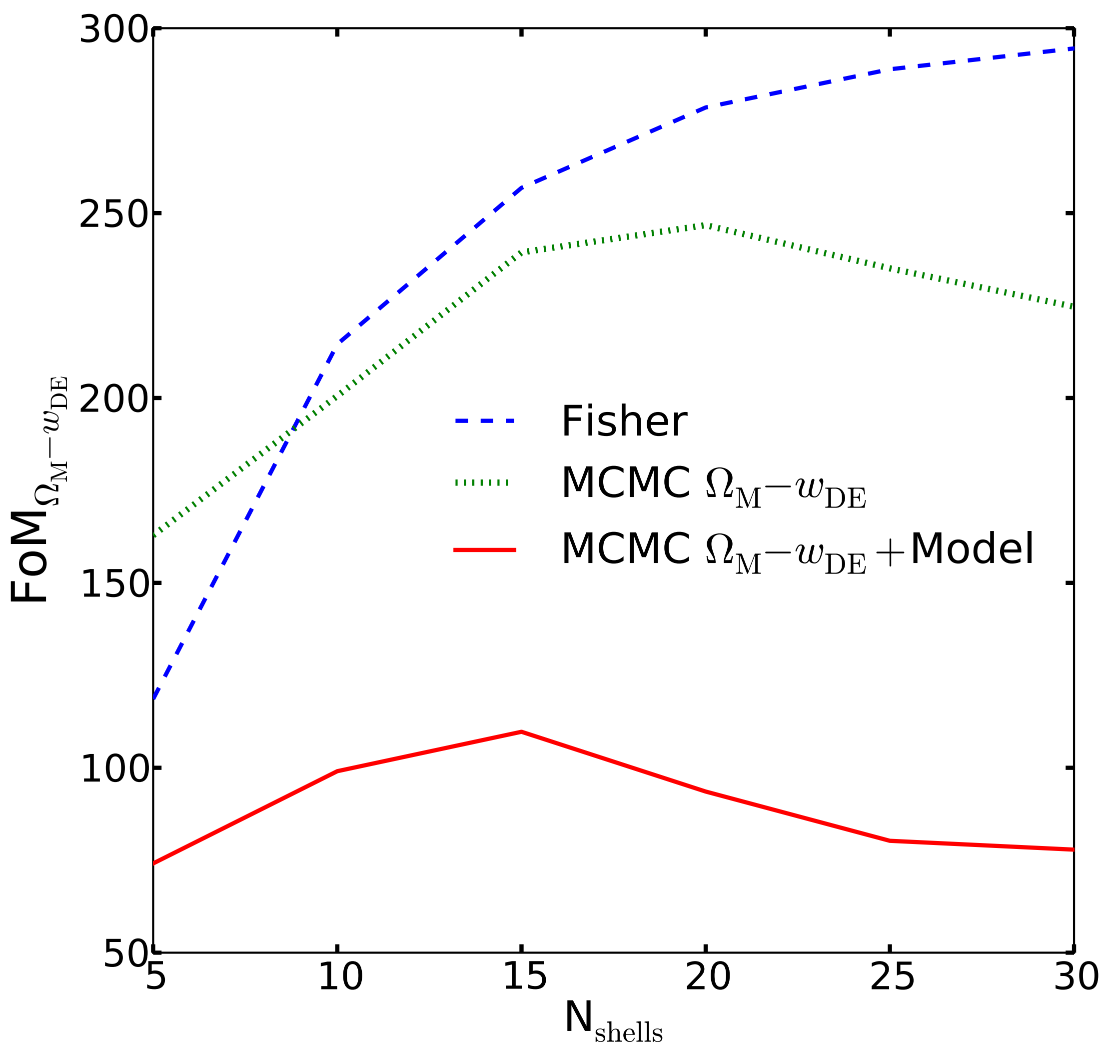
* **BOSS** is a part of SDSS-III.
* Designed to constrain DE through **BAO** measurements.
* Total area of **10,000 deg^2**.
* Comoving volume of **7.3 Gpc^3**.
* **Spectroscopic redshifts** for:
    * 1.2×10^6 LGs at $0.1 < z < 0.7$,
    * 1.6×10^5 QSO at $2.3 < z < 2.8$.



CLUSTERING TOMOGRAPHY ON BOSS-DR12

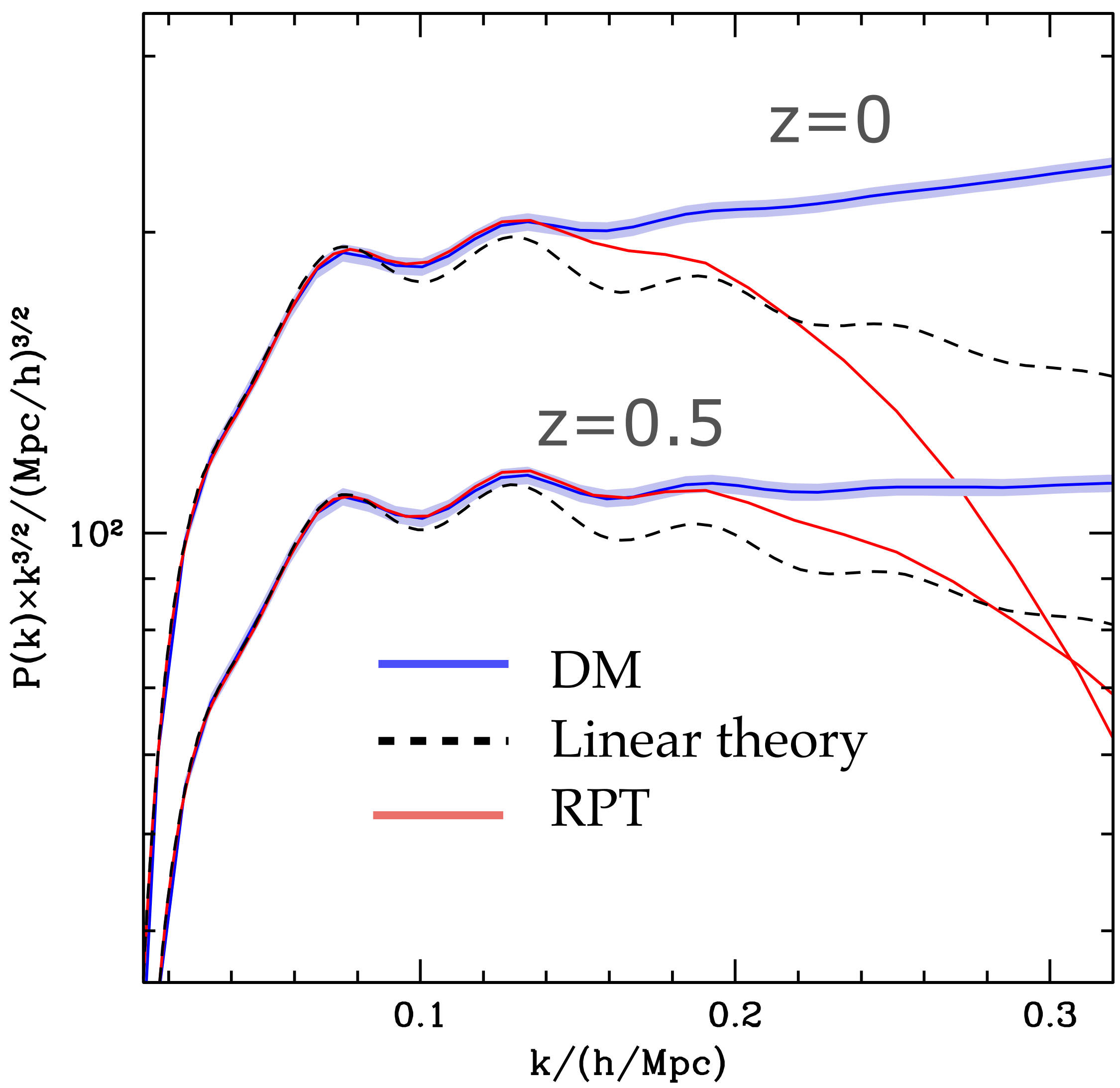
Optimization of the number of bins

- ★ Based on Di Dio et al. (2014).
- ★ **15** shells for **CMASS**
  0.43< z < 0.7 (~60k objects per shell).
- ★ **18** shells for **combined sample**
  0.2< z < 0.7 (~ 70k objects per shell).
- ★ Two **cross-correlations** per shell.



CLUSTERING TOMOGRAPHY ON BOSS-DR12

Modelling of BAO and RSD: gRPT.



(Scoccimarro et al., in prep.)

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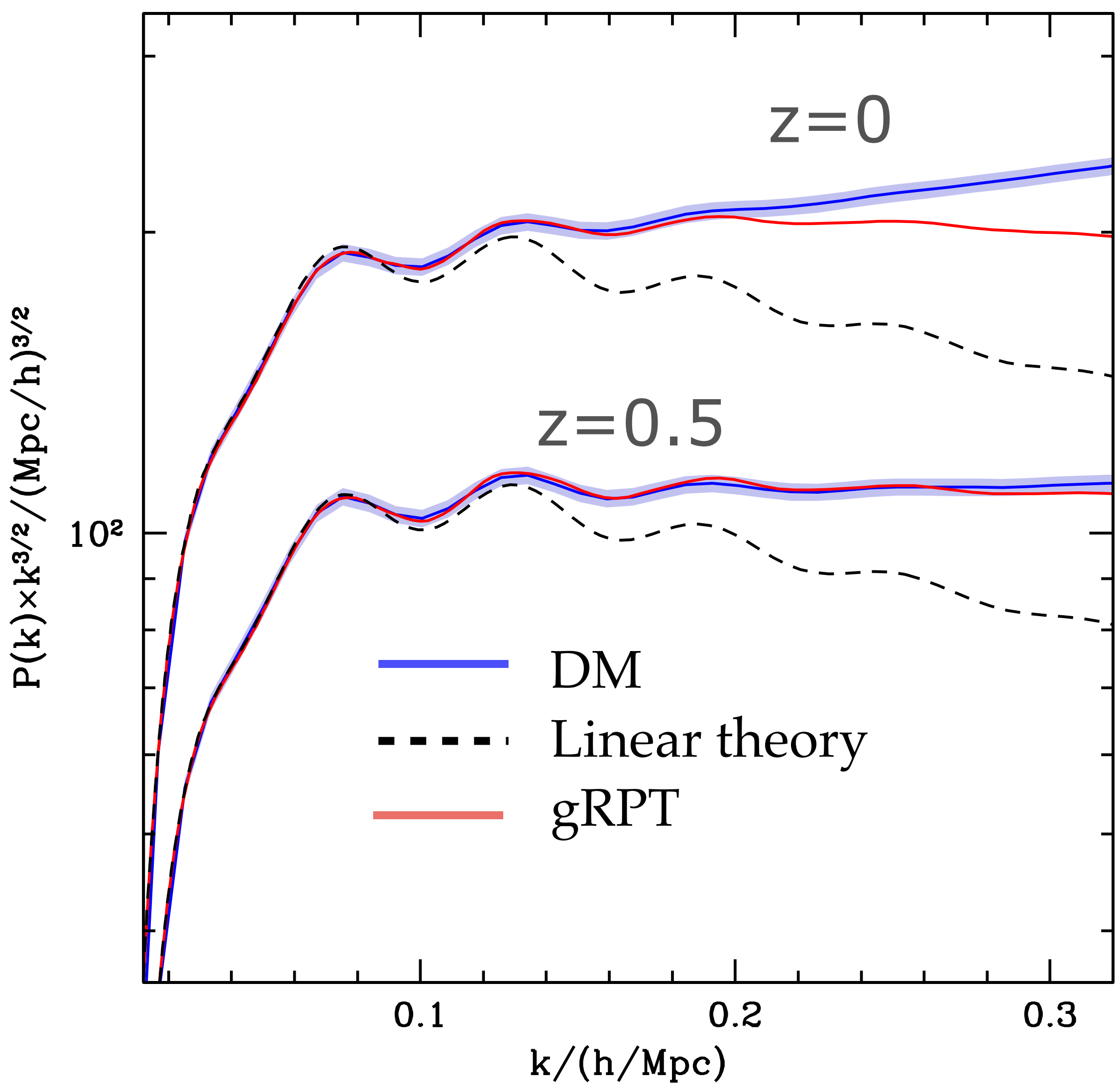

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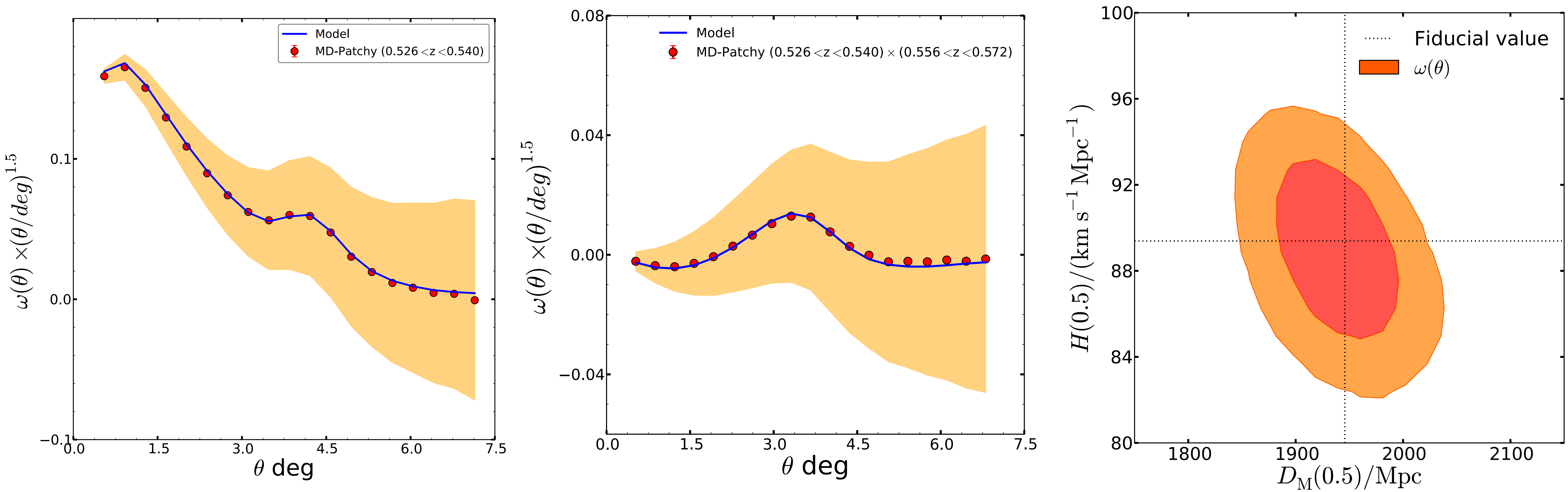
CLUSTERING TOMOGRAPHY ON BOSS-DR12

Test of model (gRPT+bias+RSD) against mocks.



MD-Patchy mocks (Kitaura et al., in prep)

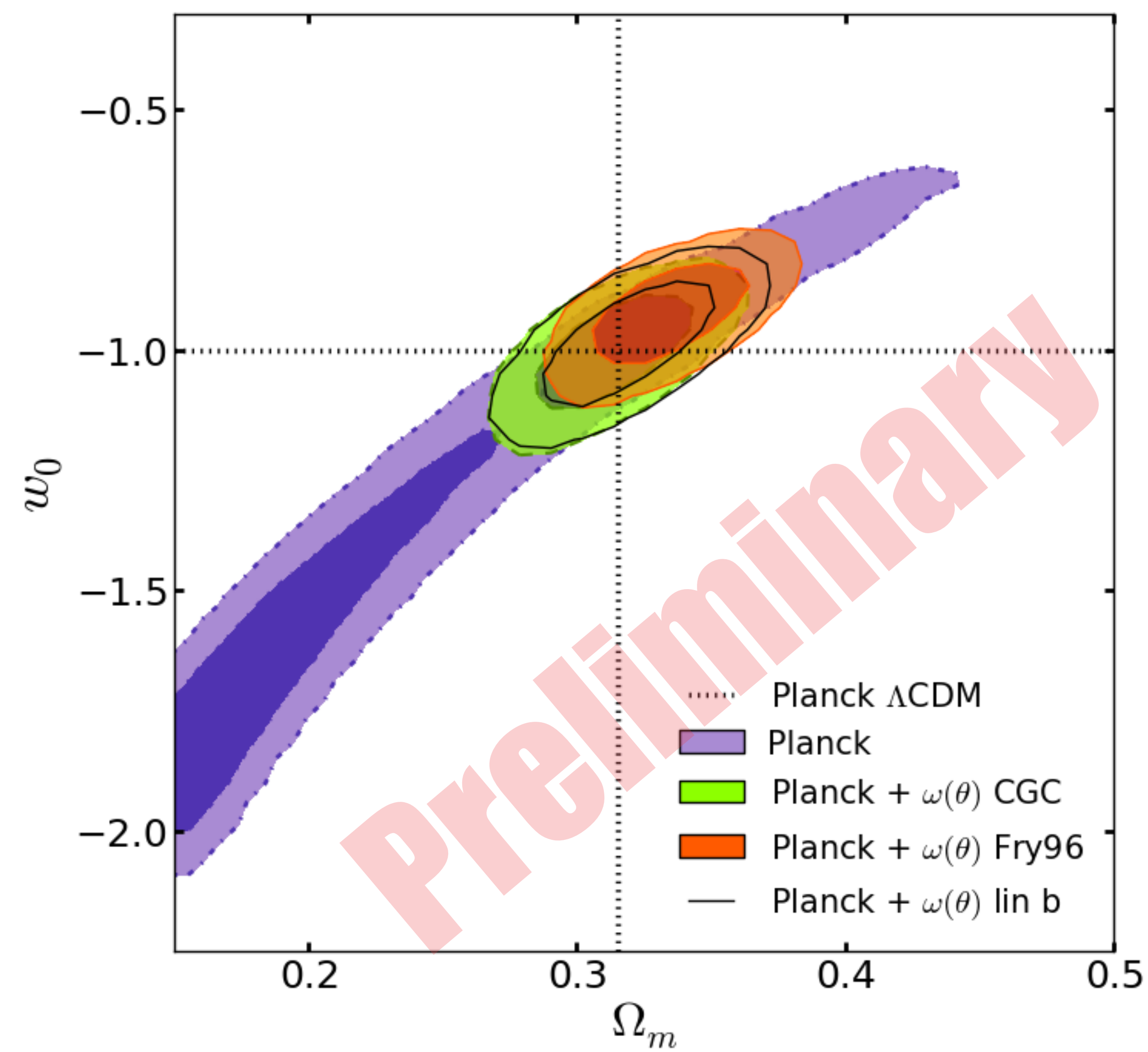
CLUSTERING TOMOGRAPHY ON BOSS-DR12

★ Preliminary constraints

➡ Using **Planck** TT+lowTEB (arXiv: 1502.01589) **distance priors**.

➡ Test 3 models for the **bias evolution**:

- ➡ Constant galaxy clustering (**CGC**),
- ➡ Passive evolution (**Fry** J. N., 1996),
- ➡ **Linear** evolution.



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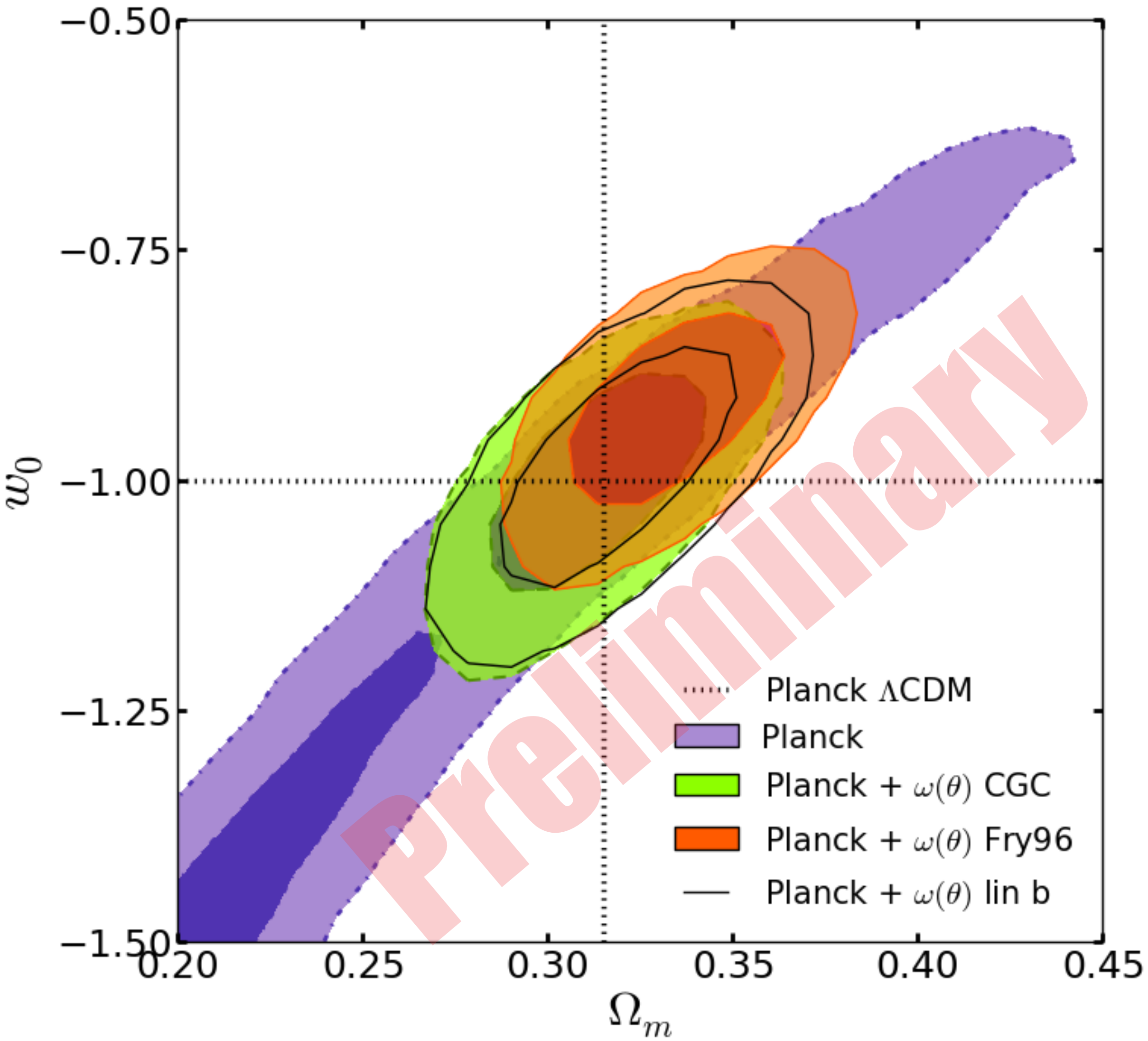

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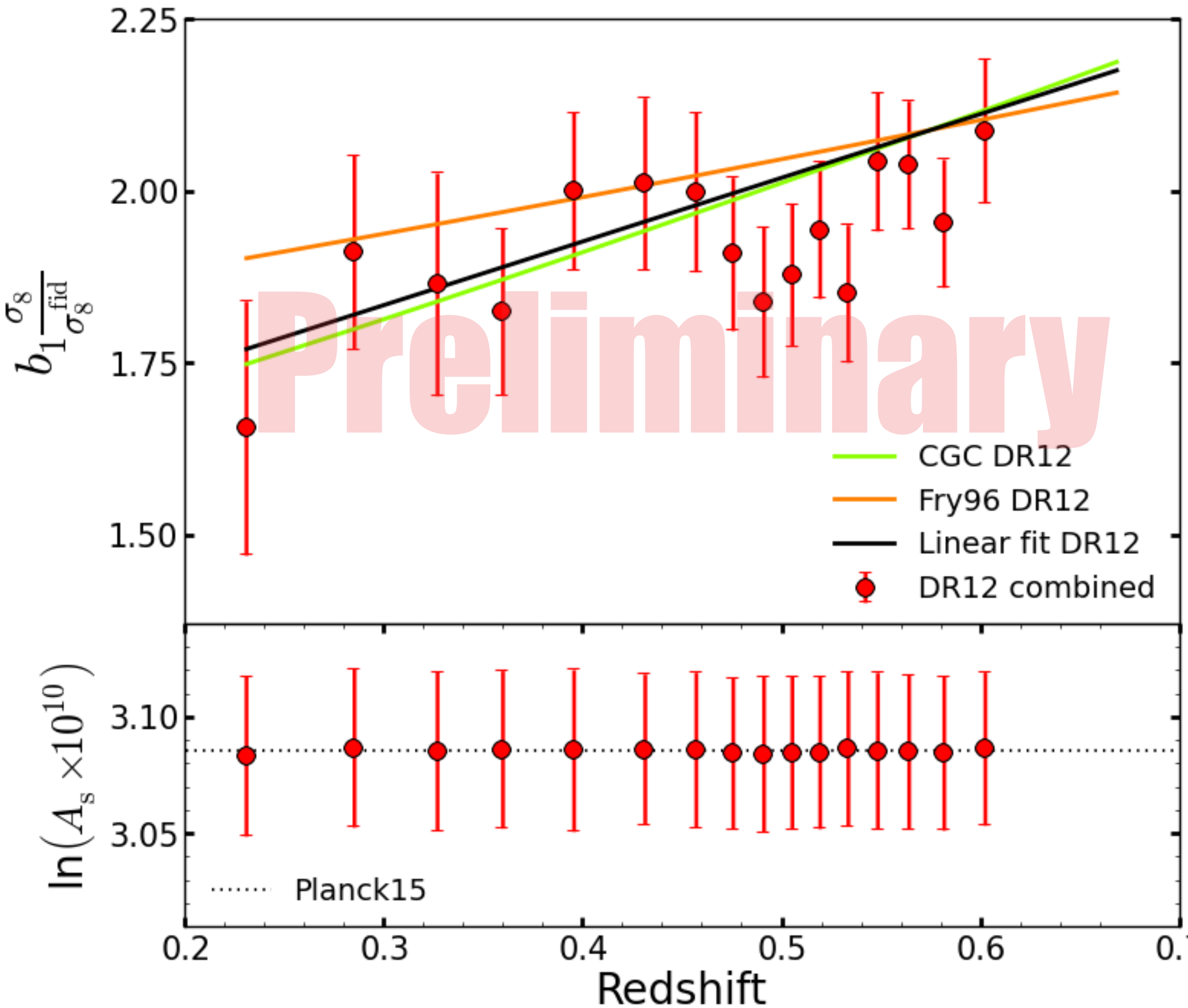
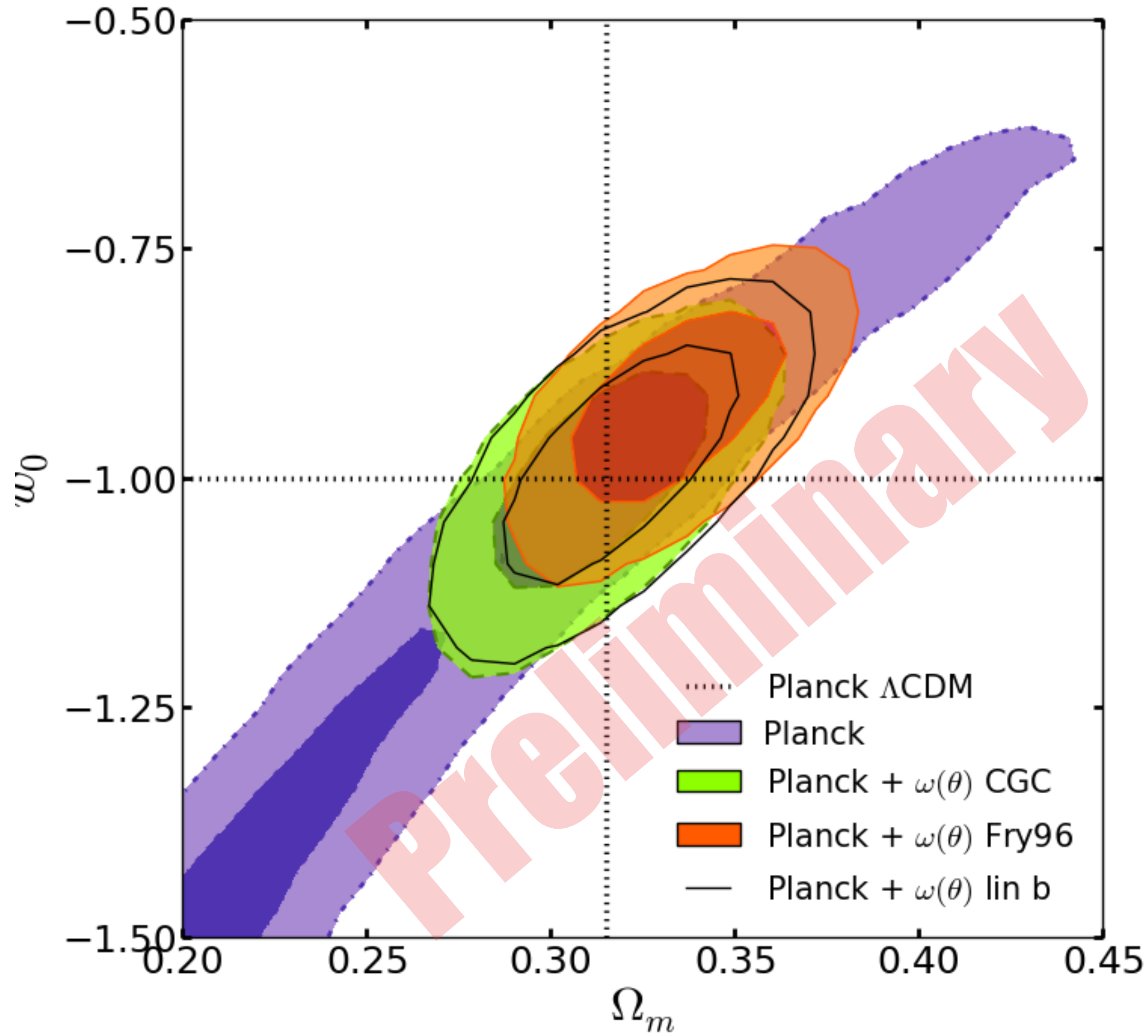
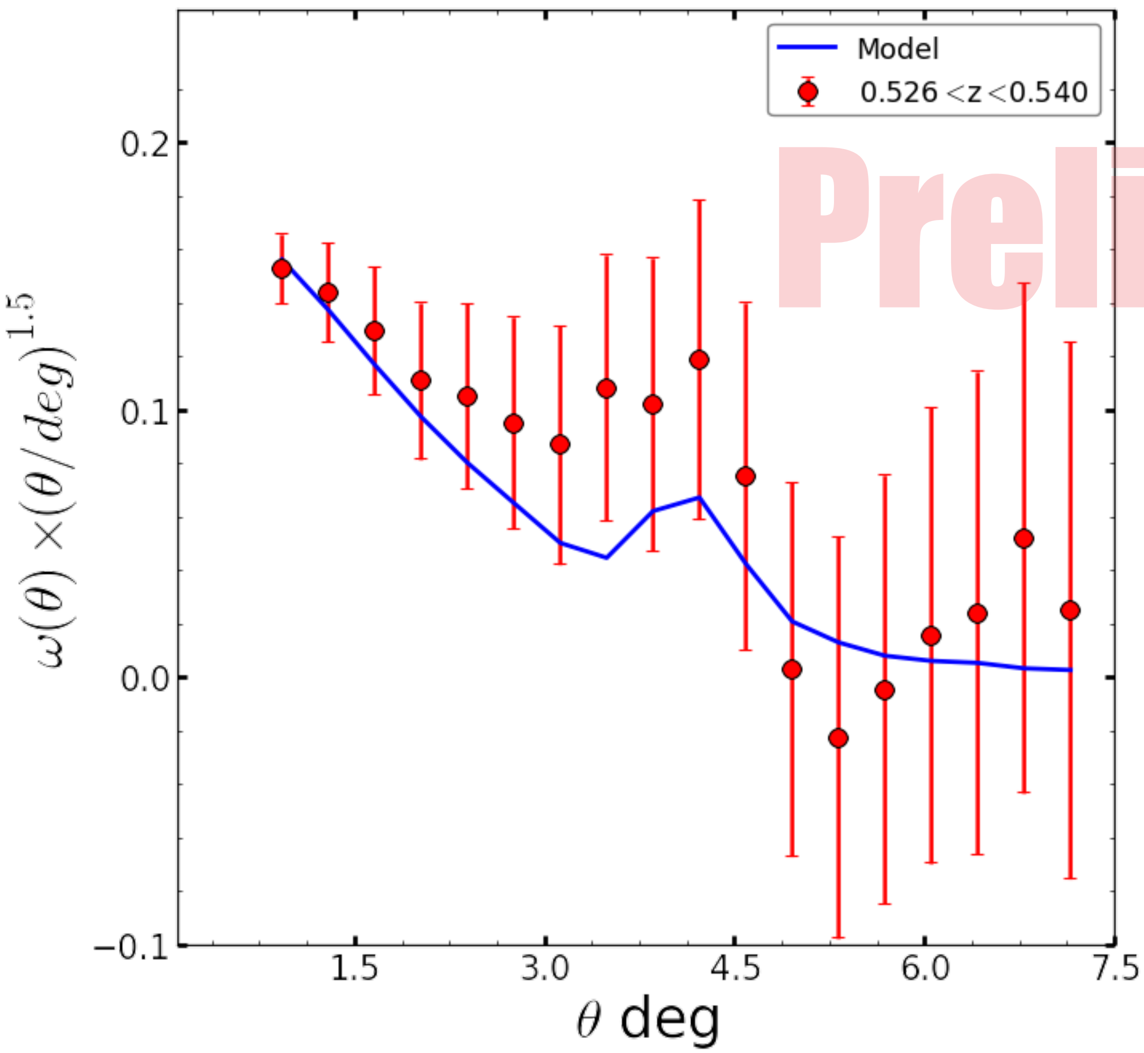




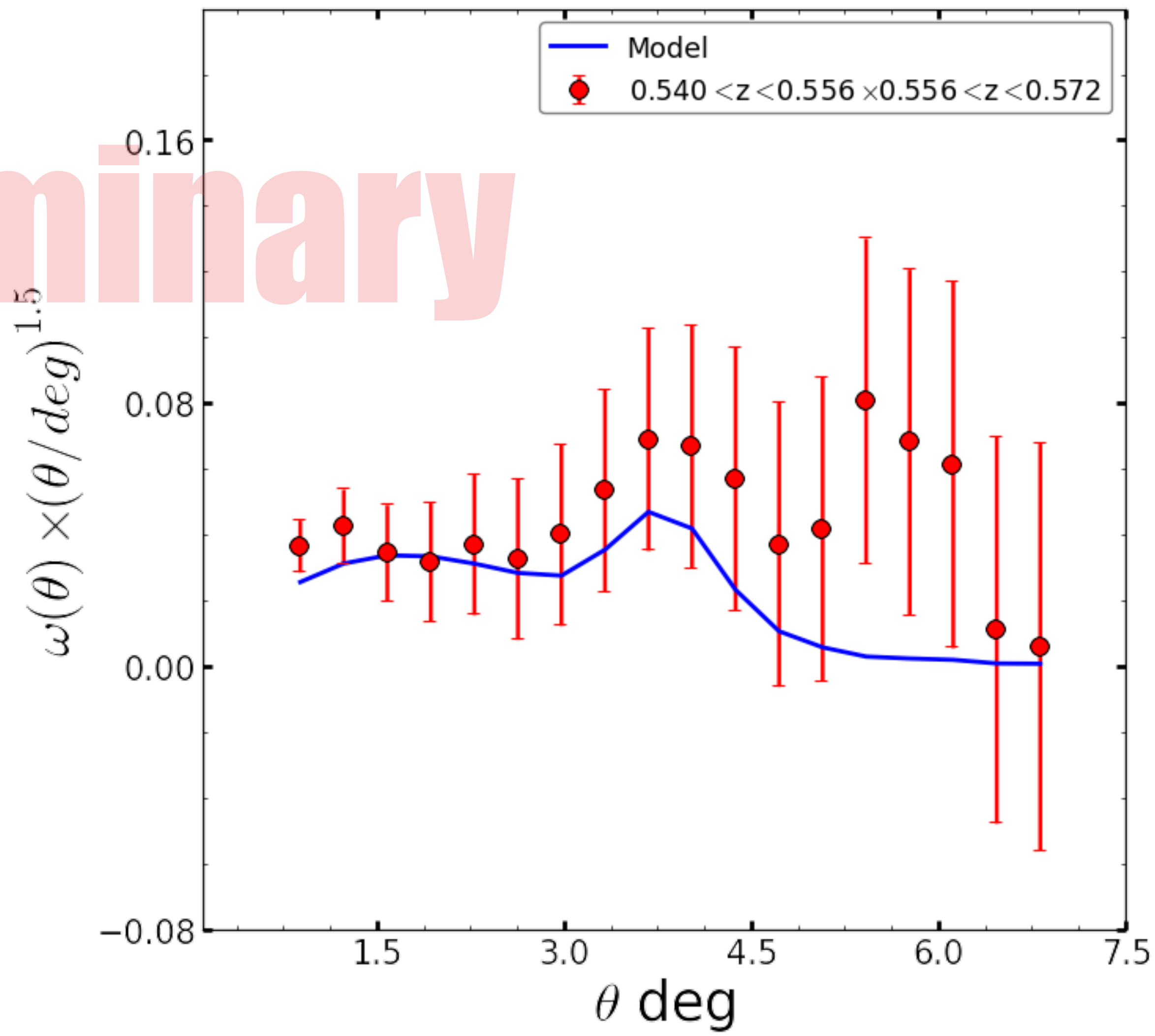
SUMMARY

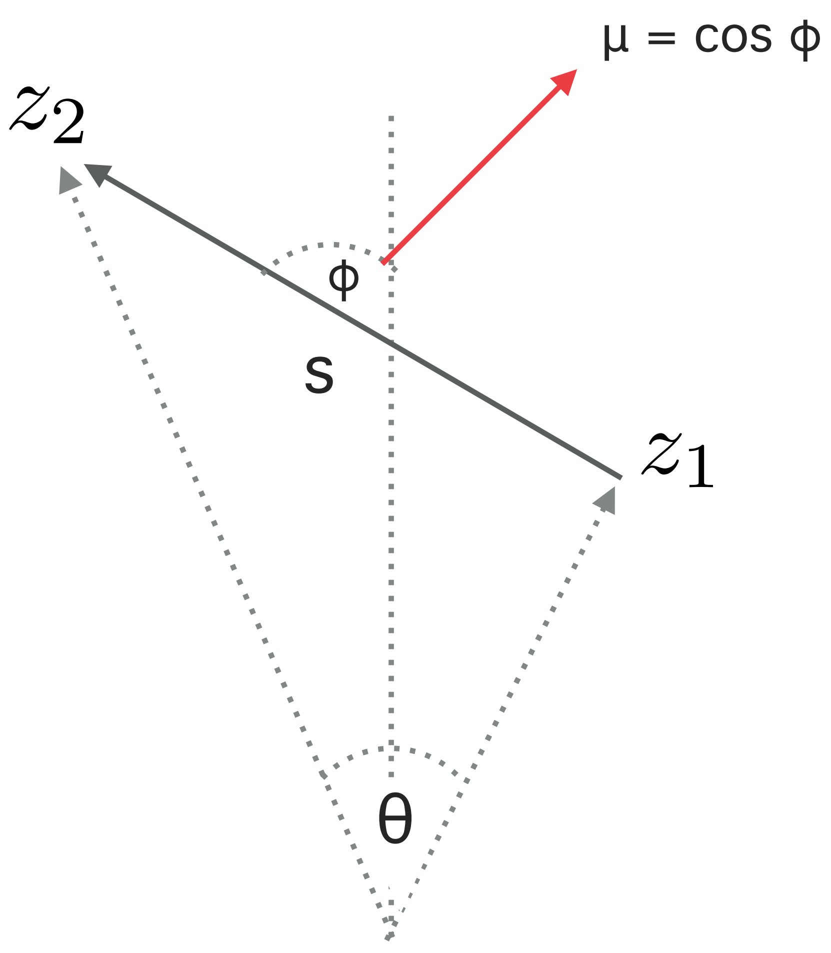
- **Clustering tomography** is a good alternative to traditional BAO analysis.
- It uses **angular** auto- and cross-correlation functions in **thin redshift-shells** as cosmological prove.
- We apply this tomographic approach to analyse the galaxy clustering using on **BOSS-DR12**.
- Final analysis on BOSS coming soon.

Back up slides…



Preliminary





$$\omega(\theta) = \int\int dz_1 dz_2 \phi(z_1)\phi(z_2)\xi(s,\mu)$$

$$s = \sqrt{r^2(z_1) + r^2(z_2) - 2r(z_1)r(z_2)\cos\theta}$$

$$\mu = \frac{r^2(z_1) - r^2(z_2)}{s||\vec{r}(z_1) + \vec{r}(z_2)||}$$

The full covariance matrix can be obtained as:

$$\mathrm{Cov}_{\mathrm{i,j}}^{(\mathrm{m,n}),(\mathrm{p,q})} = \sum_{\ell,\ell'\geq 2} \left(\frac{2\ell+1}{4\pi}\right)^2 \mathrm{L}_\ell(\cos\theta_\mathrm{i})\mathrm{L}_{\ell'}(\cos\theta_\mathrm{j})\mathrm{Cov}_{\ell,\ell'}^{(\mathrm{m,n}),(\mathrm{p,q})}$$

where

$$\mathrm{Cov}_{\ell,\ell'}^{(\mathrm{m,n}),(\mathrm{p,q})} = \delta_{\ell\ell'} \frac{\hat{\mathrm{C}}_\ell^{(\mathrm{m,p})}\hat{\mathrm{C}}_\ell^{(\mathrm{n,q})} + \hat{\mathrm{C}}_\ell^{(\mathrm{m,q})}\hat{\mathrm{C}}_\ell^{(\mathrm{n,p})}}{\mathrm{f_{sky}}(2\ell+1)}$$

and

$$\hat{C}_\ell^{(\mathrm{p,q})} = C_\ell^{(\mathrm{p,q})} + \frac{\delta_{\mathrm{pq}}}{\bar{\mathrm{n}}^{\mathrm{p}}}$$

is the observed angular power spectrum.

CLUSTERING TOMOGRAPHY ON BOSS-DR12

➡ Constant galaxy clustering (**CGC**),

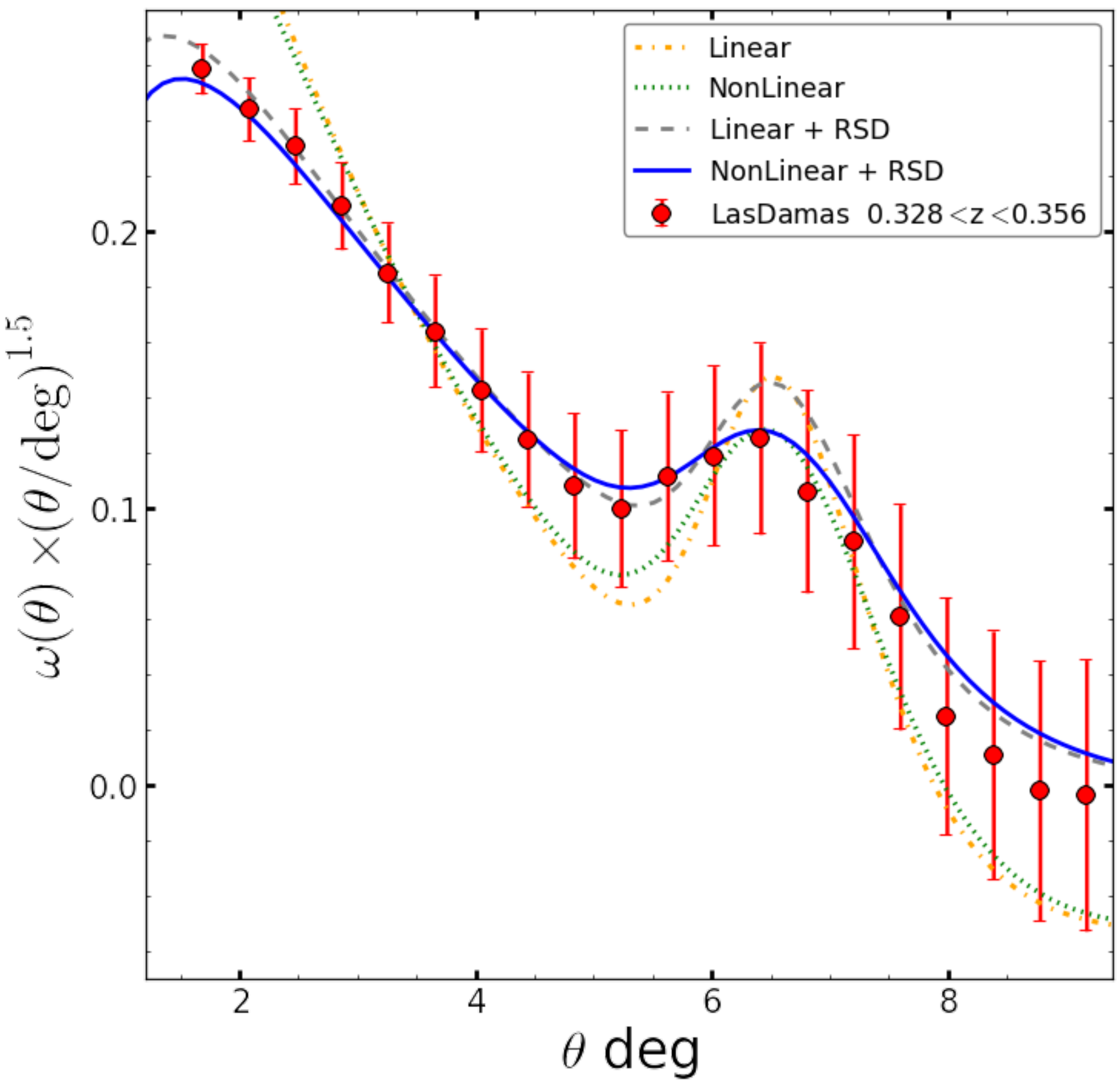
$$b(z) = b_0 \frac{D(z_{\rm ref})}{D(z)}$$

➡ Passive evolution (**Fry** J. N., 1996),

$$b(z) = 1 + (b_0 - 1)\frac{D(z_{\rm ref})}{D(z)}$$

➡ **Linear** evolution.

$$b(z) = b_0 + b'(z - z_{\rm ref})$$



Linear
NonLinear
Linear + RSD
NonLinear + RSD
LasDamas 0.328 <z <0.356
0.2
0.1
0.0
$\omega(\theta) \times (\theta/\deg)^{1.5}$
2
4
6
8
θ deg