Cosmological implications of the BOSS-CMASS clustering wedges

Ariel Sánchez

MAX-PLANCK-GESELLSCHAFT

MPE

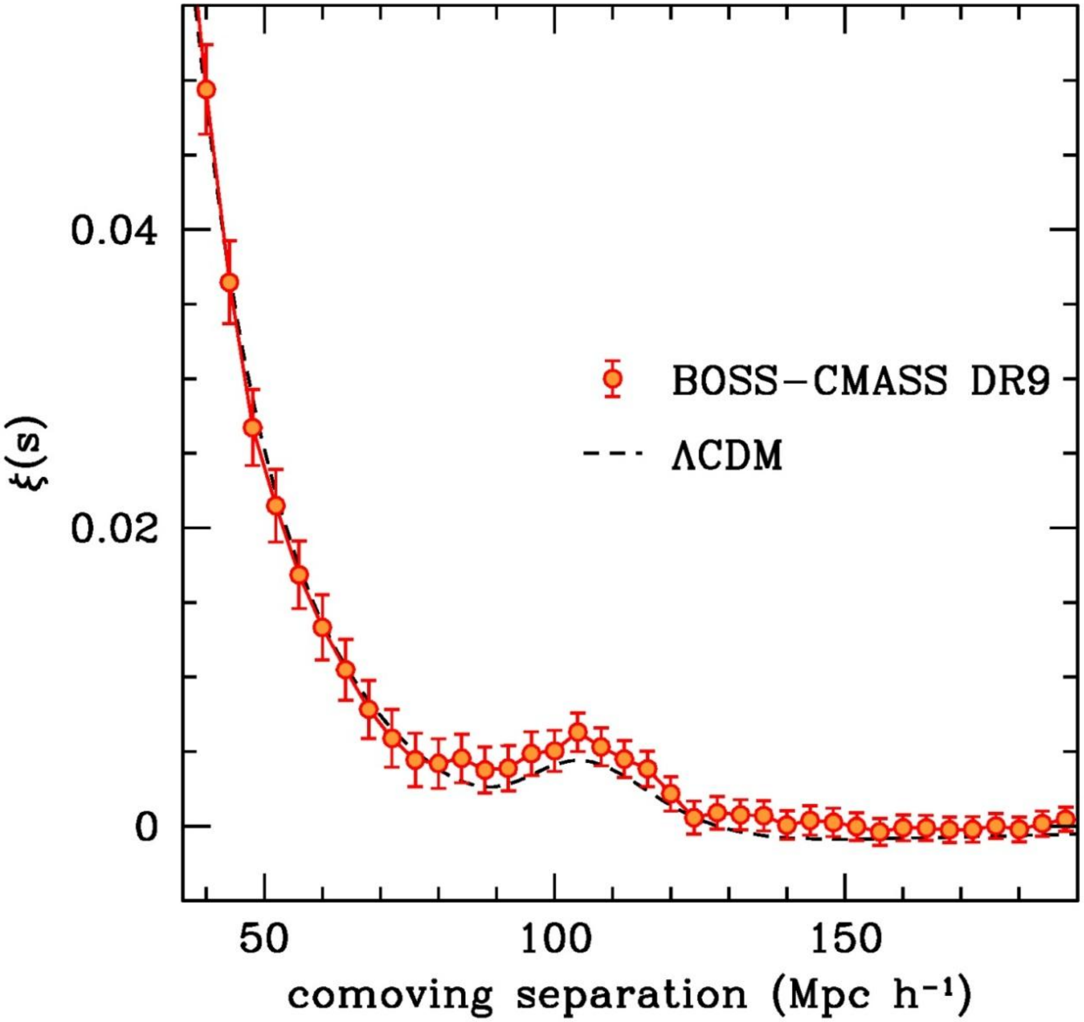
Eyal Kazin, C. Chuang. A. Cuesta, D. Eisenstein, M. Manera, F. Montesano, W. Percival, P. Prada, A. Ross & the BOSS galaxy clustering working group

Ripples in the cosmos – Durham – 25.07.2013

Outline

- Angle-averaged clustering measurements from BOSS.
- Modelling LSS observations.
- Anisotropic clustering measurements: clustering wedges.
- Cosmological parameters from BOSS-DR9.
- The future: DR10 and DR11.

The CMASS correlation function



Sánchez et al. (2012)

- Monopole $\xi(s)$ from Sánchez et al. (2012)
- Correction of sys. as in Ross et al. (2012)
- $\mathbf{C}_{ij}$ from 600 mocks (Manera et al. 2013)
- Clear detection of the BAO peak.

Potential systematics

- Great opportunity for precision cosmology.
- Control of syst. errors becomes increasingly important.
- The shape of $\xi(s)$ is affected by

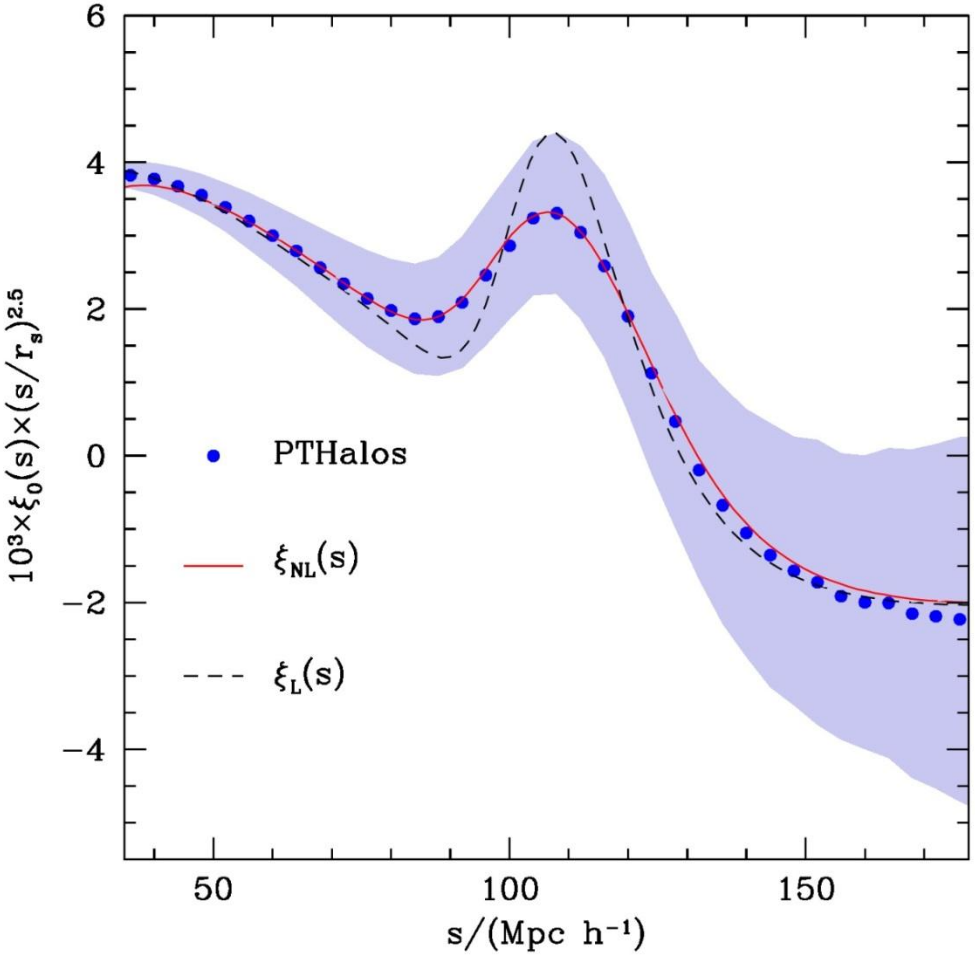
  - Non-linear evolution.

  - Redshift-space distortions.

  - Galaxy bias.

The shape of ξ(s)

- It is possible to model the full shape of $\xi(s)$ (Crocce & Scoccimarro 2008; Sánchez, Baugh & Angulo 2008)



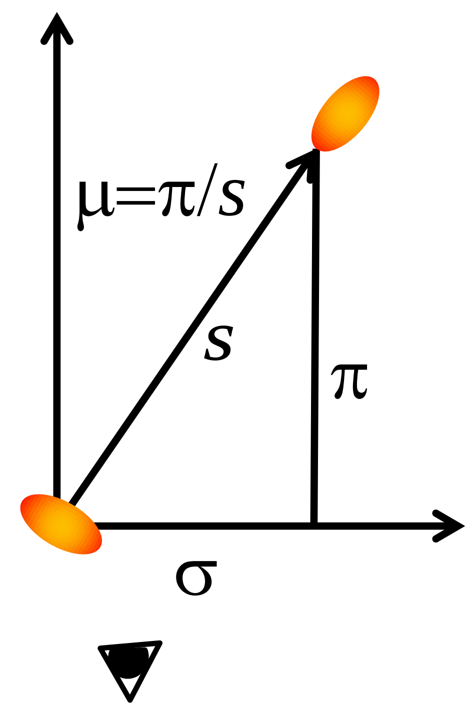
The full shape of ξ(μ,s)

- The monopole ξ(s) constrains the combination

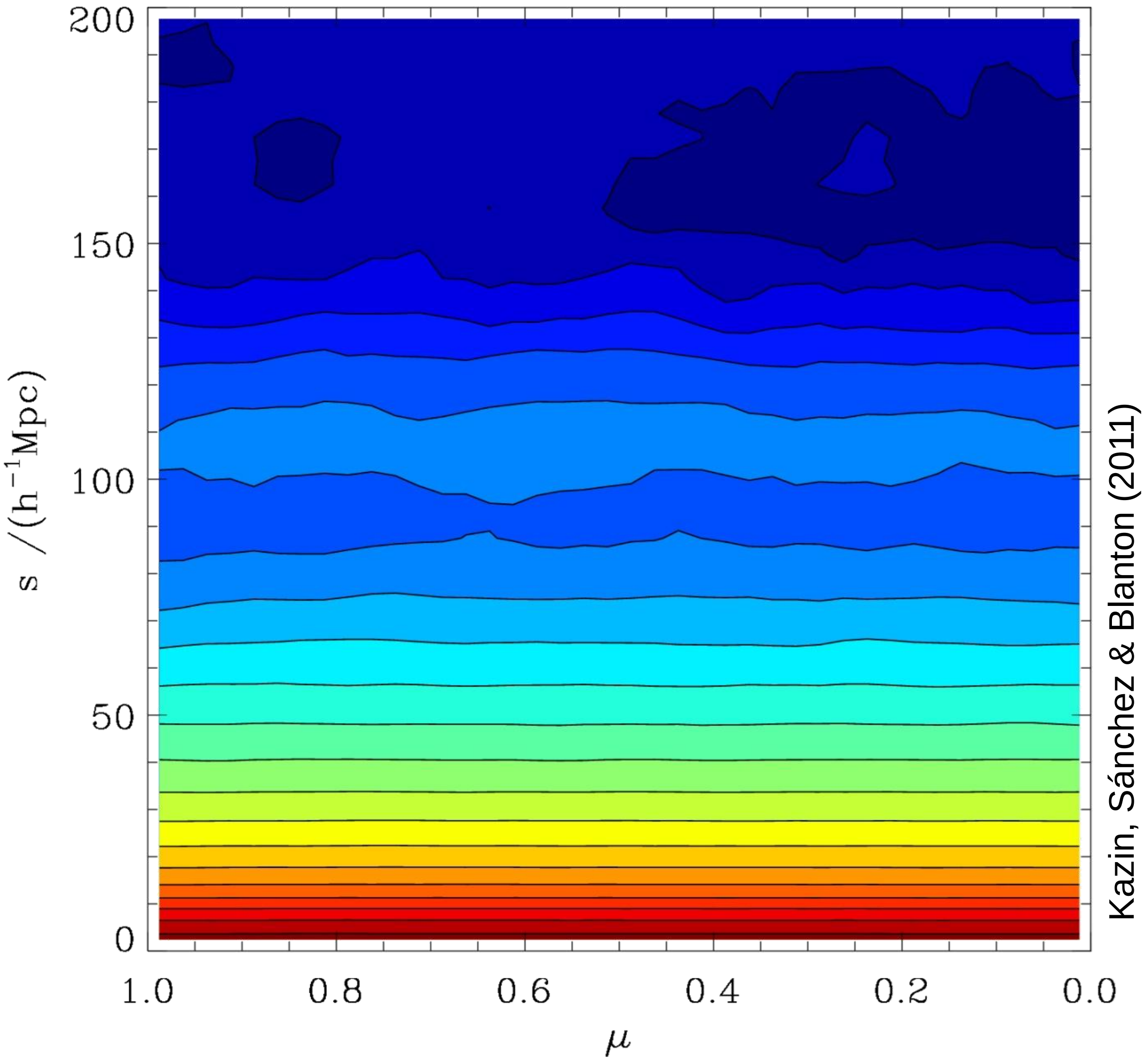
$$r_s(z_d)/D_V(z) = r_s(z_d)/\left(D_A(z)^2 cz/H(z)\right)^{1/3}$$

- Clustering can be analyzed in terms of (μ,s)

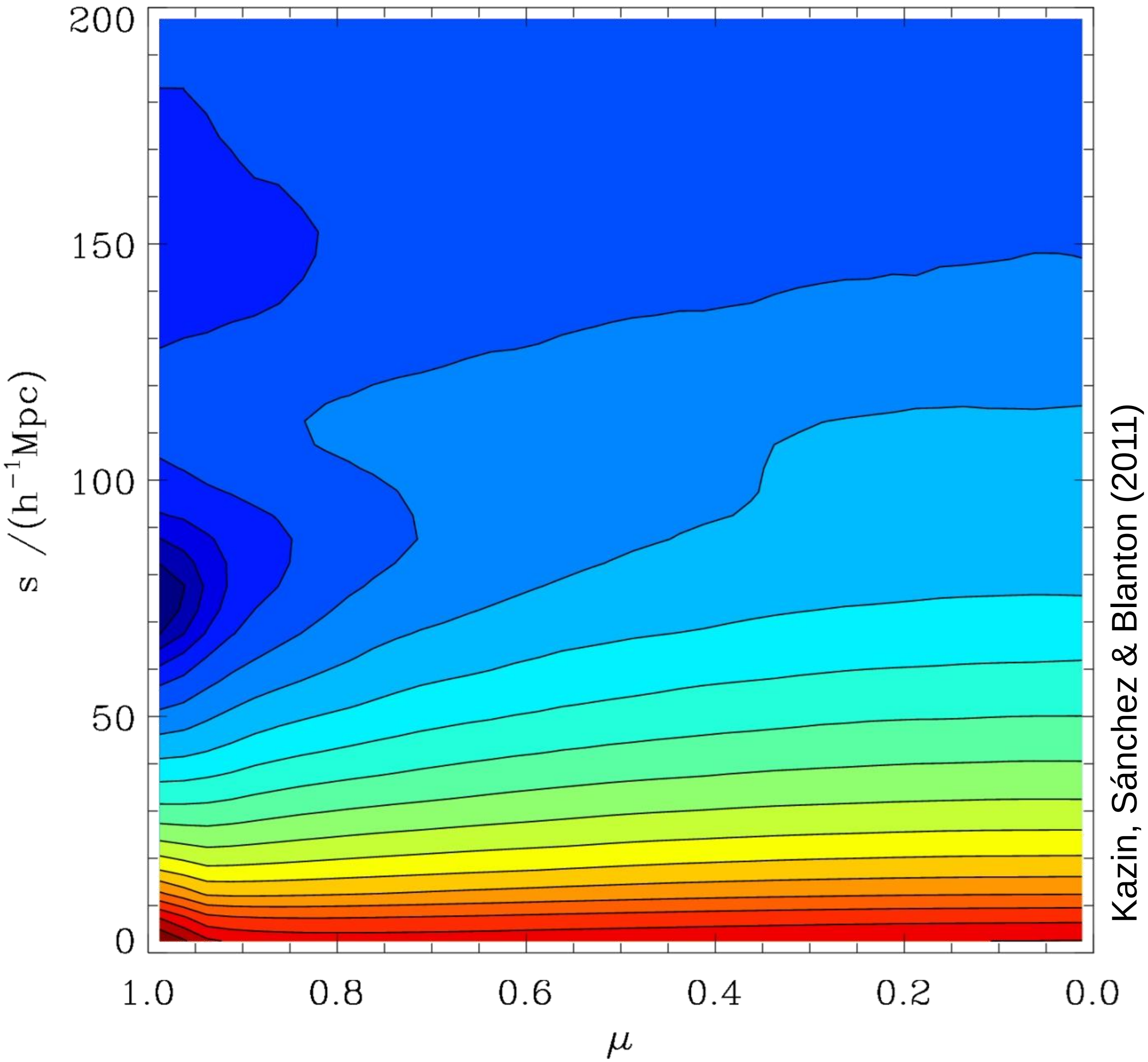
- There is more information in the full shape of ξ(μ,s).



The full shape of ξ(μ,s)



The full shape of $\xi(\mu,s)$

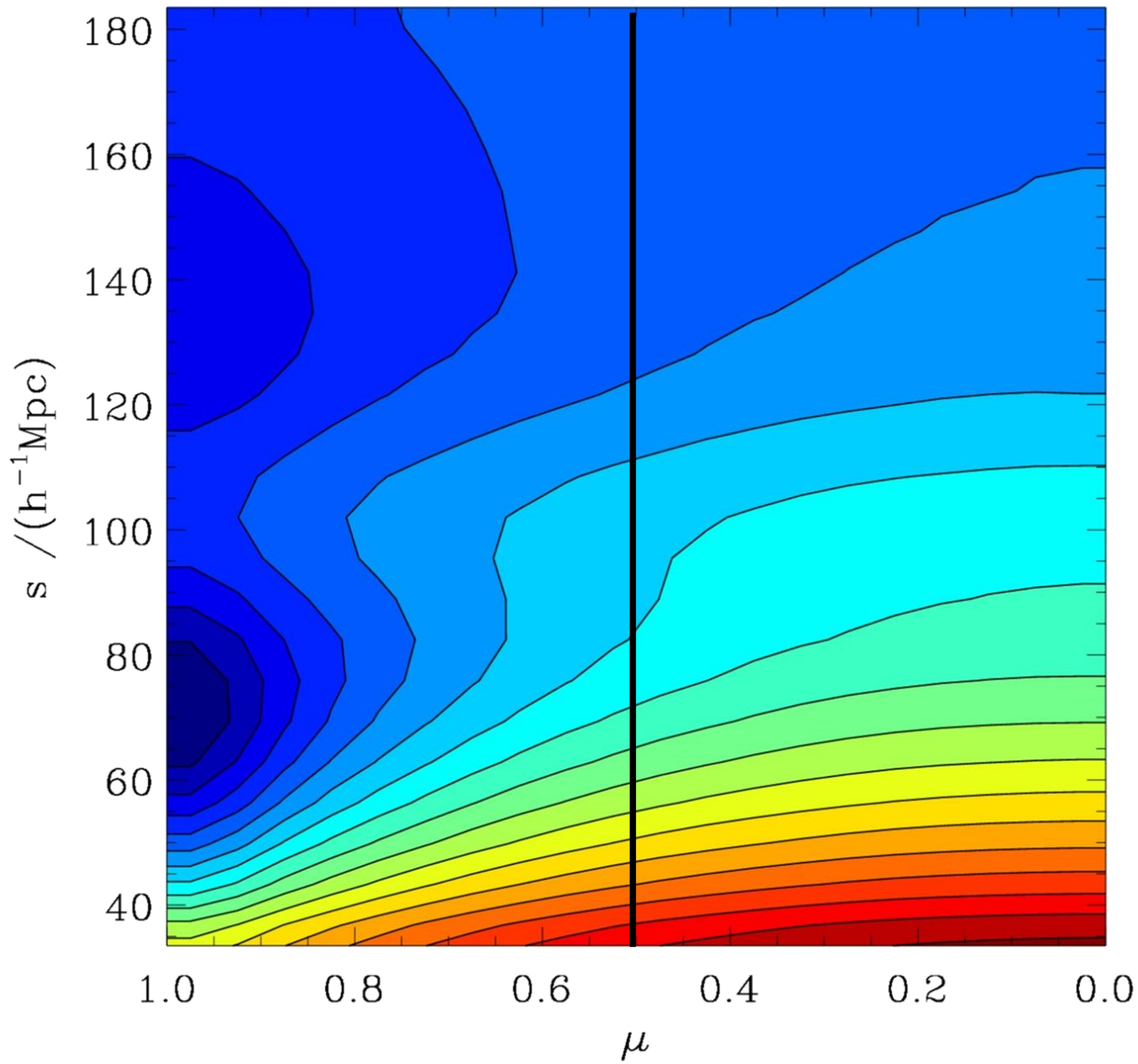


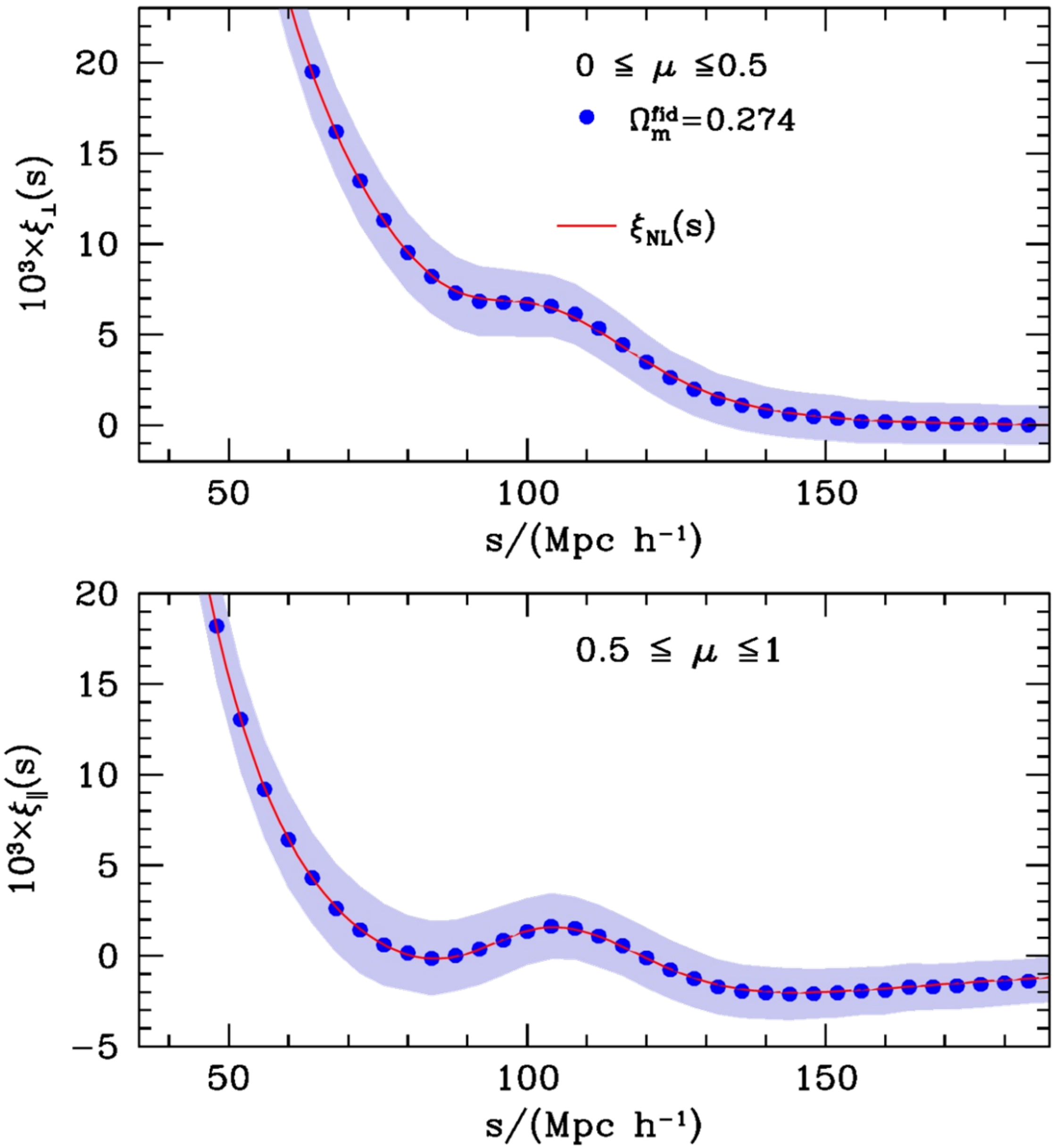
Clustering wedges

- Full shape of $\xi(\mu,s)$ requires: redshift-space distortions, large covariance matrix, low signal-to-noise.
- Need alternatives to extract $H(z)$ and $D_A(z)$.
- One possibility: the monopole-quadrupole pair (Padmanabhan & White 2008).
- Alternatively we can use *clustering wedges* (Kazin, Sánchez & Blanton 2012)

$$\xi_{\Delta\mu}(s) = \frac{1}{\Delta\mu}\int_{\mu_{\min}}^{\mu_{\max}} \xi(\mu, s)\, d\mu$$

Clustering wedges





0 ≦ μ ≦0.5
Ω_m^{fid}=0.274
$\xi_{NL}(s)$
$10^3\times\xi_\perp(s)$
s/(Mpc h⁻¹)
0.5 ≦ μ ≦1
$10^3\times\xi_\parallel(s)$
s/(Mpc h⁻¹)

Anisotropic clustering

- Two wide clustering wedges can constrain

$$y_{\parallel} = r_{\mathrm{s}}(z_{\mathrm{d}}) / \left(\frac{cz}{H(z)} \right)$$

$$y_{\perp} = r_{\mathrm{s}}(z_{\mathrm{d}}) / D_{\mathrm{A}}(z)$$

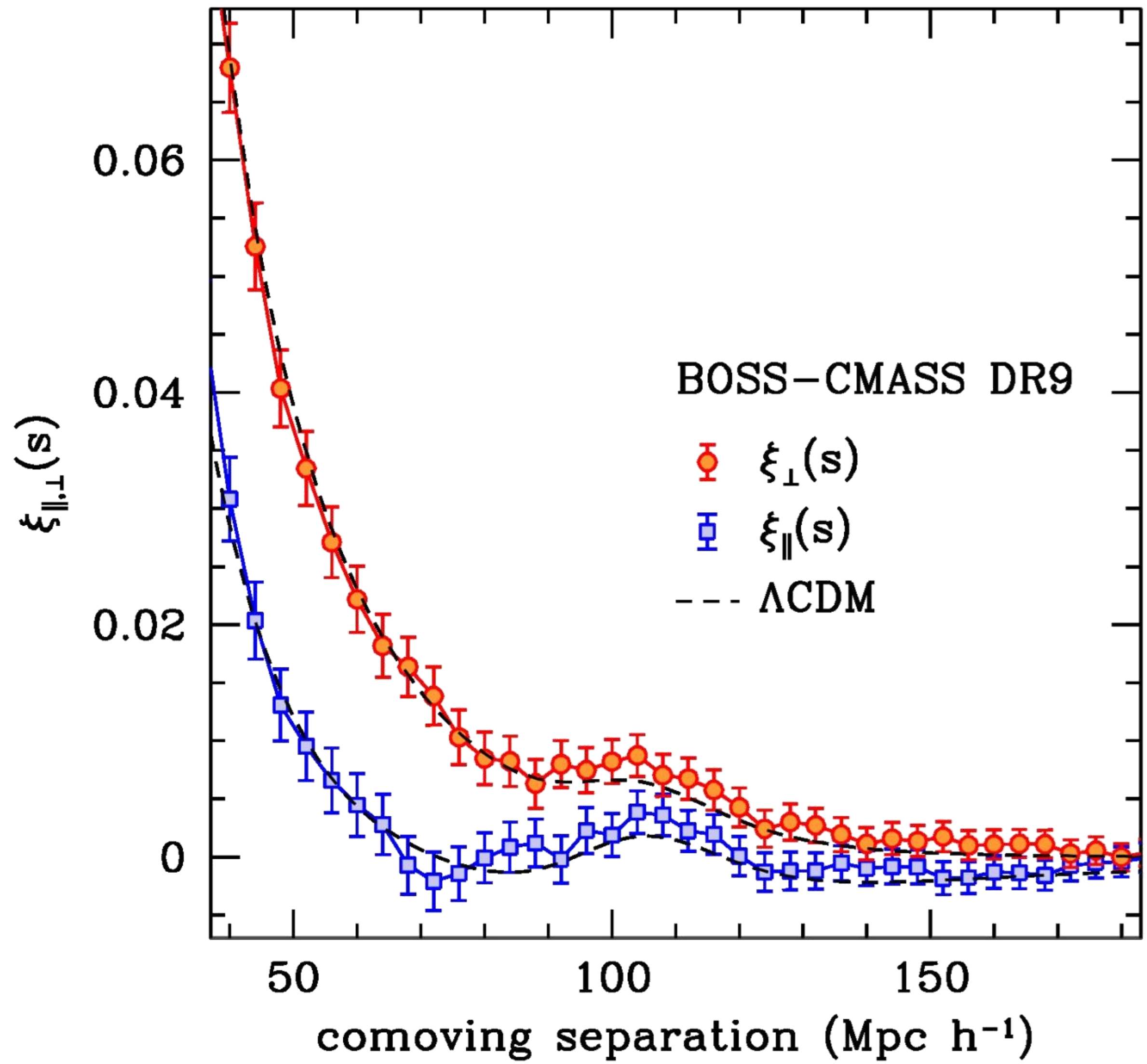
- Full shape is also sensitive to $\sigma_8 f(z)$, where

$$f(z) = \frac{d \ln D}{d \ln a} \approx \Omega_{\mathrm{m}}^{\gamma}$$

- Higher S/N ratio than full $\xi(\mu, s)$.

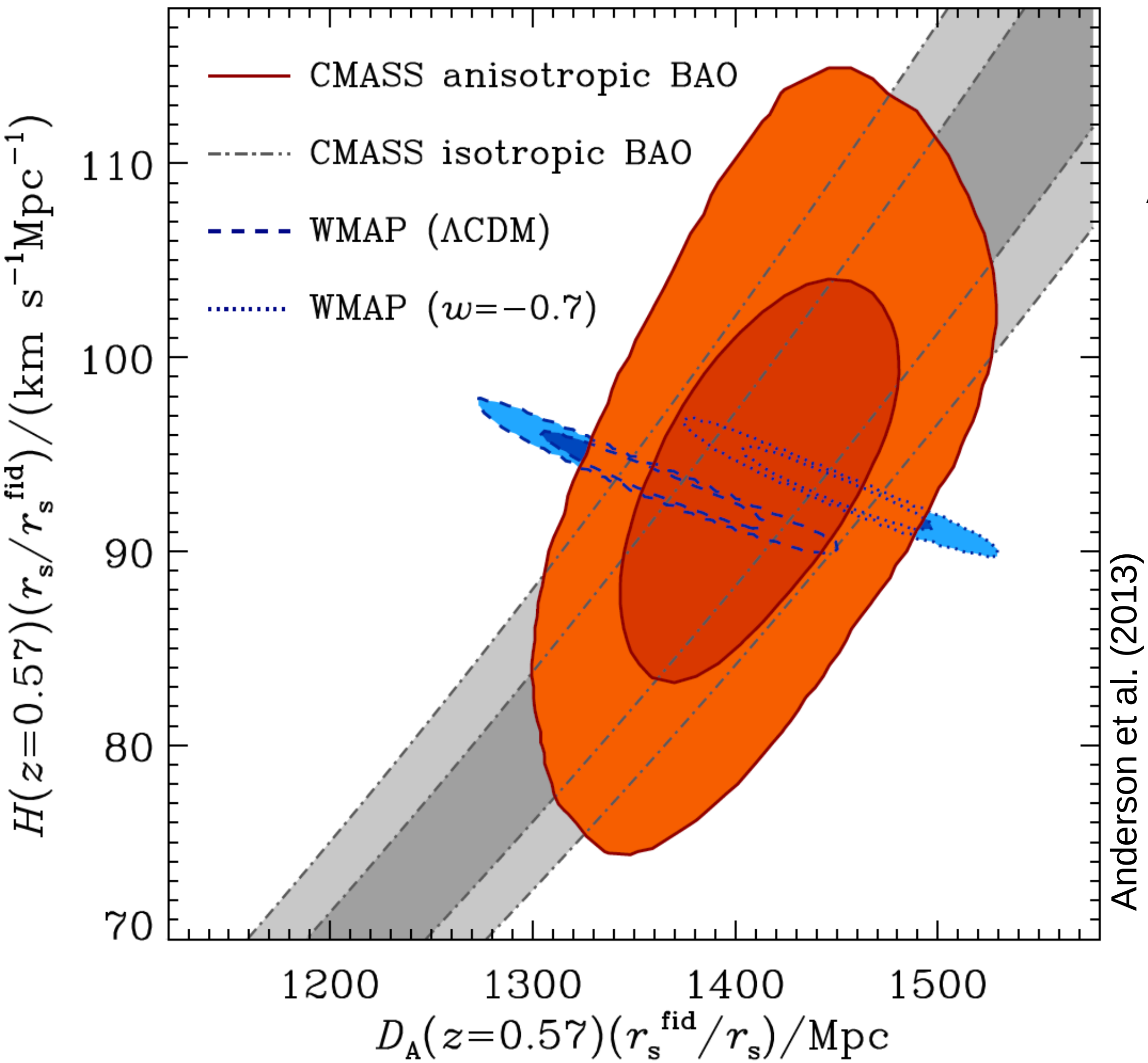
- Easier to estimate C_{ij} from mock catalogues.

CMASS-DR9 clustering wedges



Sánchez et al. (2013)

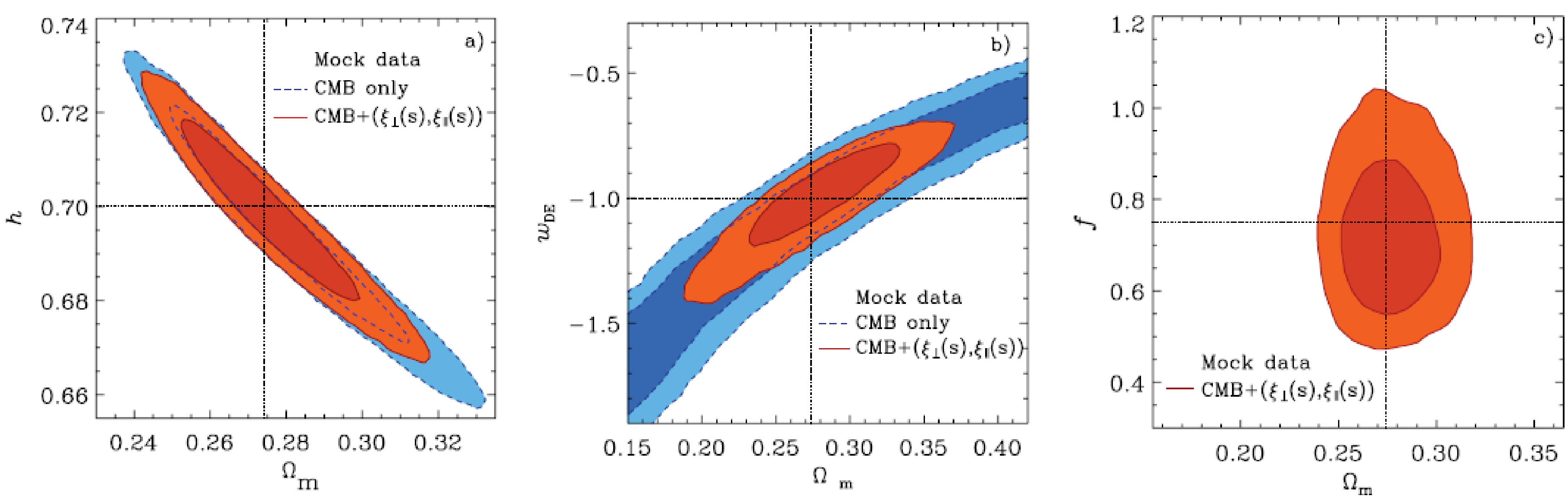
CMASS-DR9 anisotropic clustering



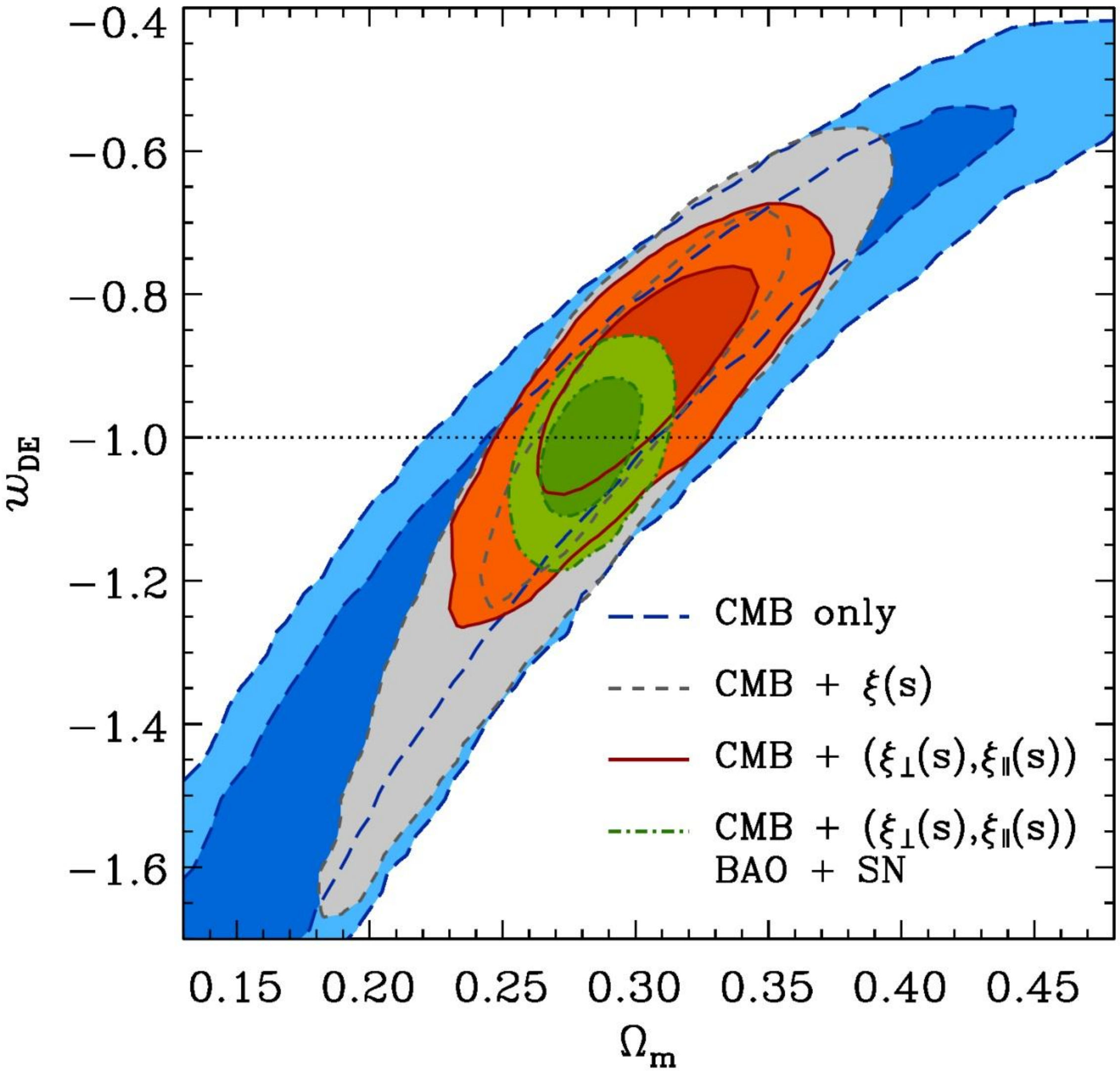
Kazin et al. (2013)
Anderson et al. (2013)

CMASS-DR9 anisotropic clustering

- Use mock catalogues to validate our methodology
- Mock CMB data combined with $(\xi_{\perp}(s), \xi_{\parallel}(s))$



The dark energy equation of state



Sánchez et al. (2013)

CMB + $\xi_0(s)$:
$\Omega_m = 0.291 \pm 0.042$
$w_{DE} = -0.99 \pm 0.20$

CMB + $(\xi_\perp(s), \xi_\parallel(s))$
$\Omega_m = 0.299 \pm 0.028$
$w_{DE} = -0.93 \pm 0.11$

All:
$\Omega_m = 0.283 \pm 0.012$
$w_{DE} = -1.01 \pm 0.06$

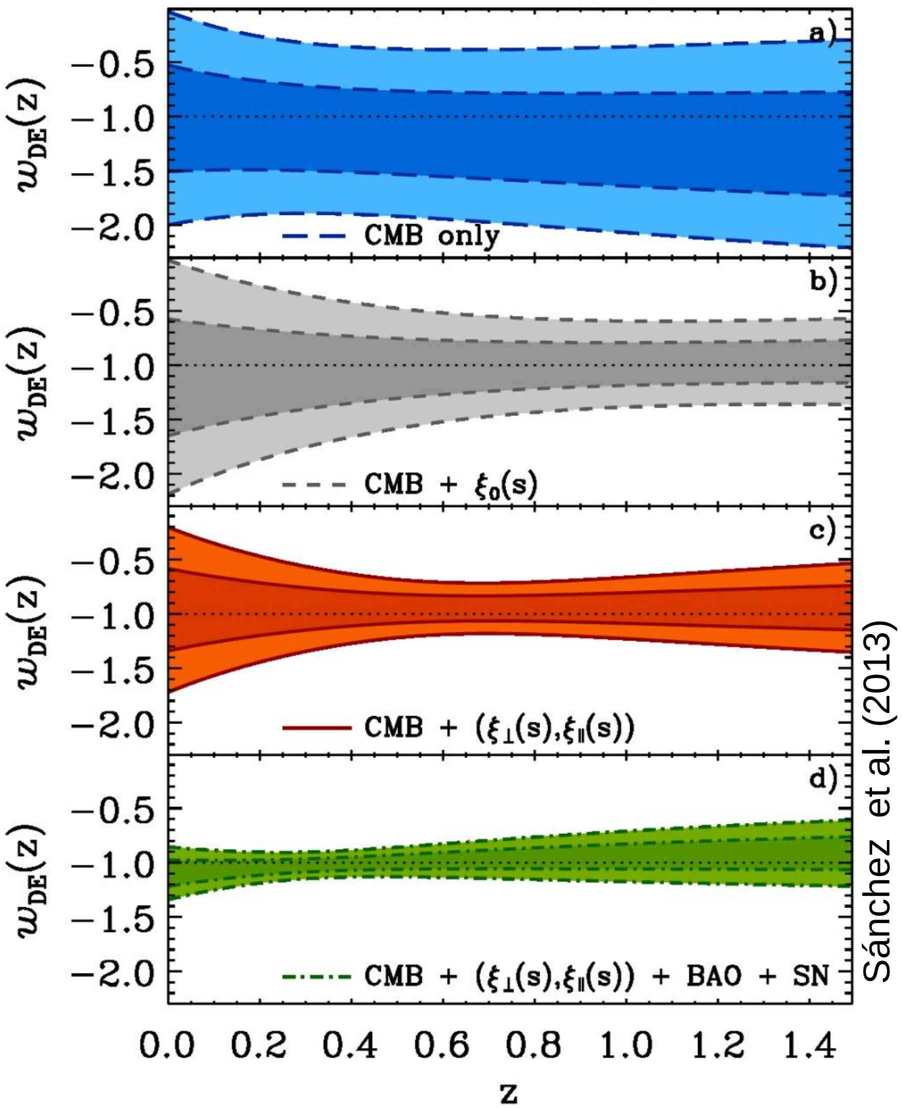
The dark energy equation of state

- We analyse the evolution of w_{DE} assuming

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

- The combination of all datasets is consistent with no evolution

All:
$$w_0 = -1.10 \pm 0.12$$
$$w_a = 0.31 \pm 0.40$$



The growth of density fluctuations

- The clustering wedges depend on the value of

$$f(z) = \frac{d\ln D}{d\ln a} \approx \Omega_m^{\gamma}$$

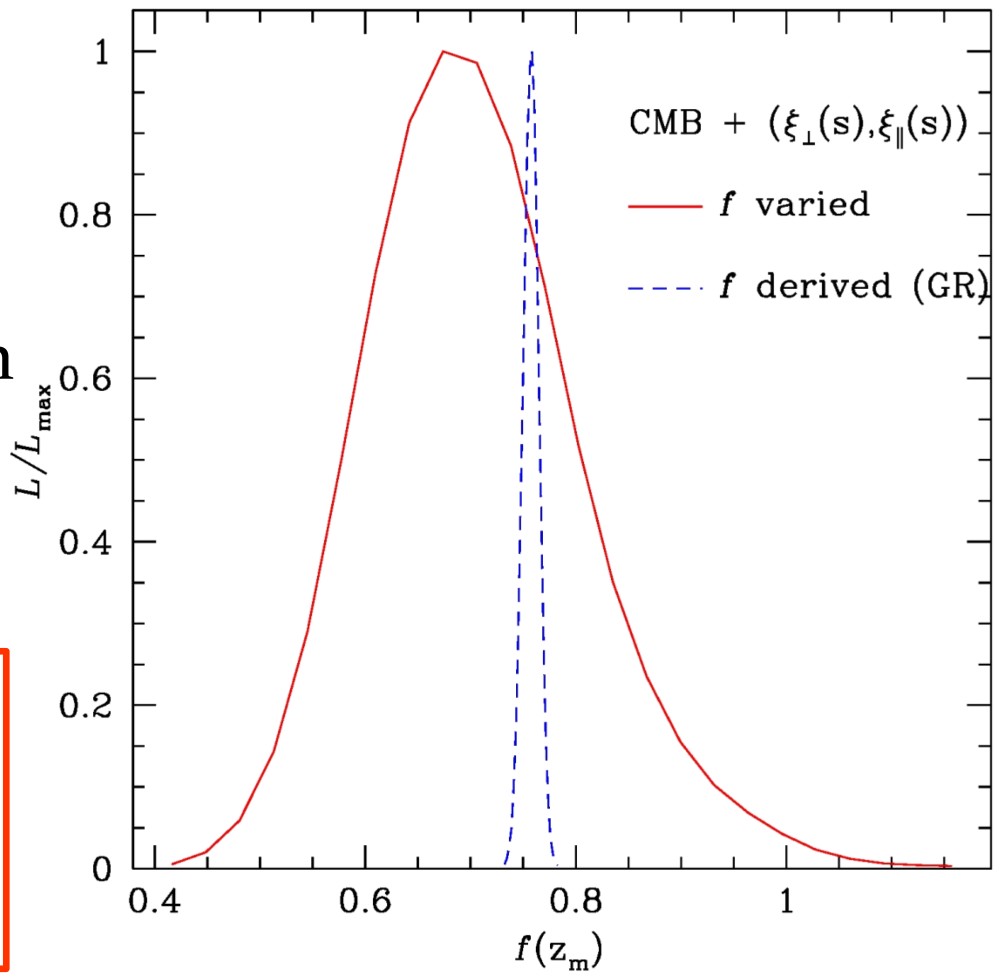
- Test for deviations from GR (Guzzo et al. 2008)

- We find:

CMB + $(\xi_{\perp}(s), \xi_{\parallel}(s))$:

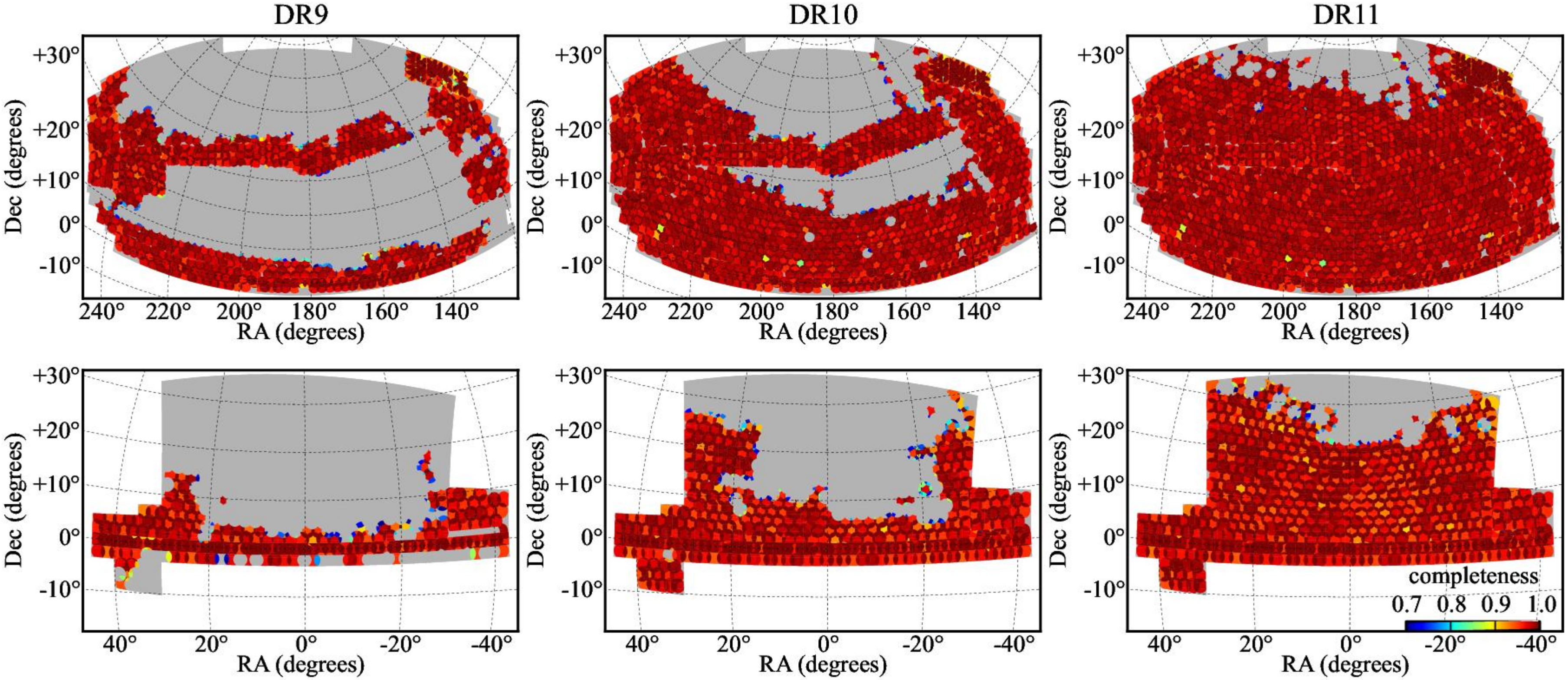
$f(z) = 0.719 \pm 0.094$

$\gamma = 0.59 \pm 0.23$

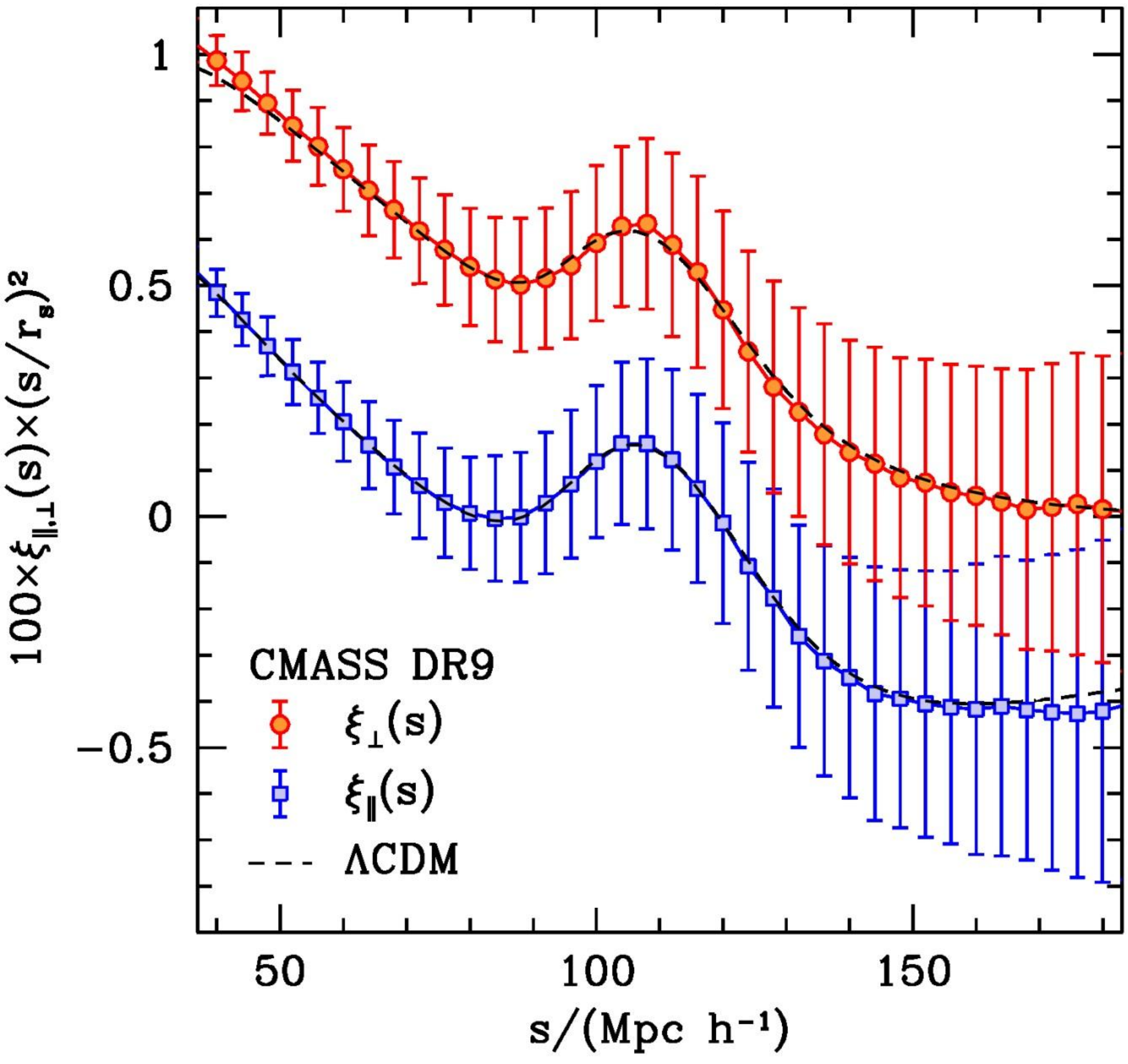


Future BOSS data releases

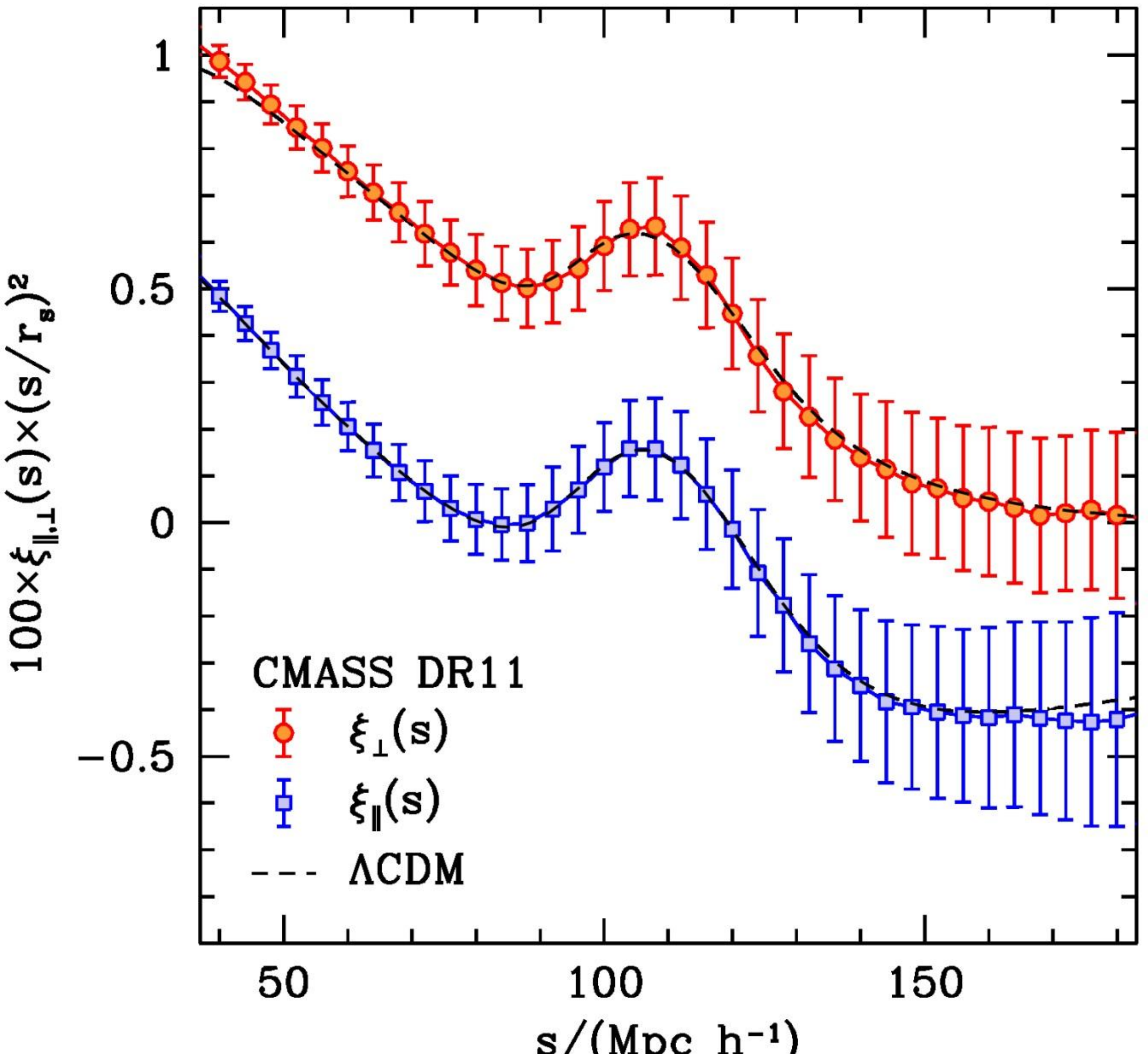
- Currently analysing the DR10 and DR11 BOSS samples



Future BOSS data releases



Future BOSS data releases



Final remarks

- Precision cosmology requires careful modelling of non-linear evolution, RSD and other systematics.

- Anisotropic clustering measurements can constrain $D_{\mathrm{A}}(z)$ and $H(z)$.

- Full shape gives additional information on $\sigma_8(z)f(z)$.

- BOSS data shows no evidence of deviations from the ΛCDM model.

- This is just the beginning: DR10+, HETDEX, Euclid, Planck, etc., will provide much tighter constraints.