PONT d'Avignon conference (April 2014)

Probing the power spectrum of matter with the galaxy clustering ratio

Bel & Marinoni 2014, A&A, 563, 36

Bel, Marinoni, Granett, Guzzo, Peacock et al. (The VIPERS Team) 2014, A&A, 563, 37

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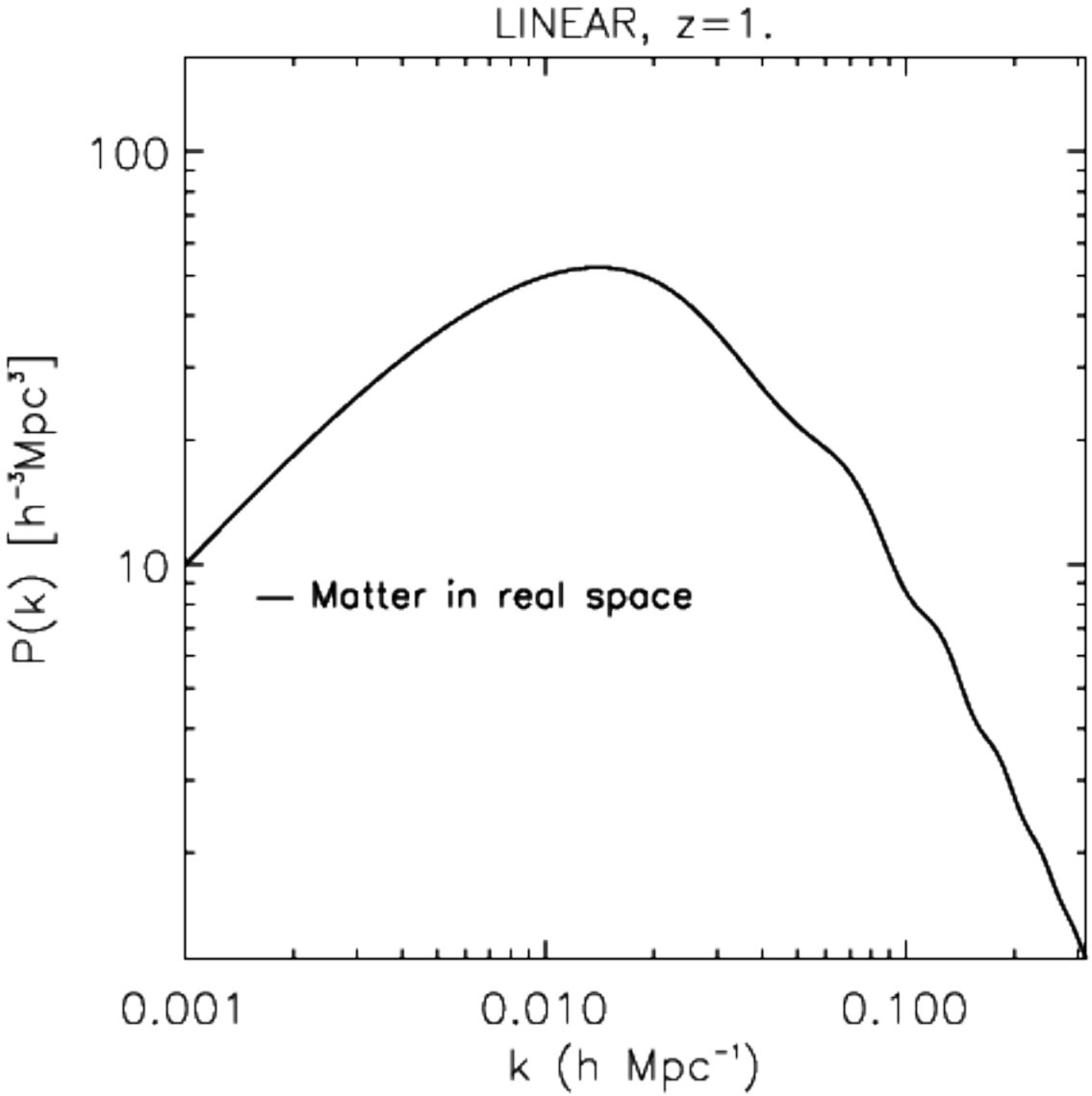
Outline

- Goal: fixing the matter power spectrum
- Tool: a new clustering statistic, the clustering ratio
- Test: blind analysis of simulations
- Results: Omega_m from SDSS DR7 and VIPERS PDR1

The Matter power spectrum



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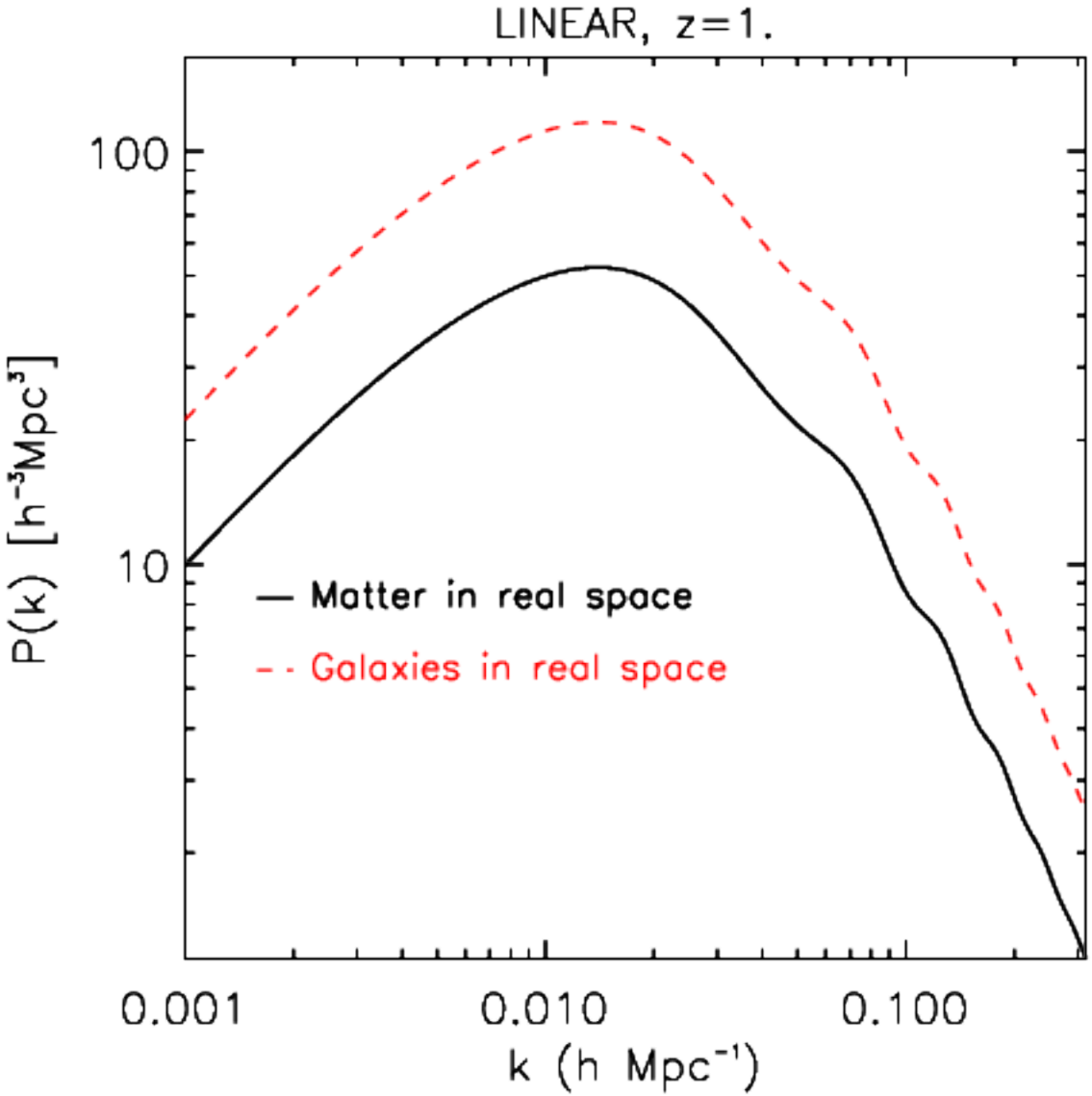
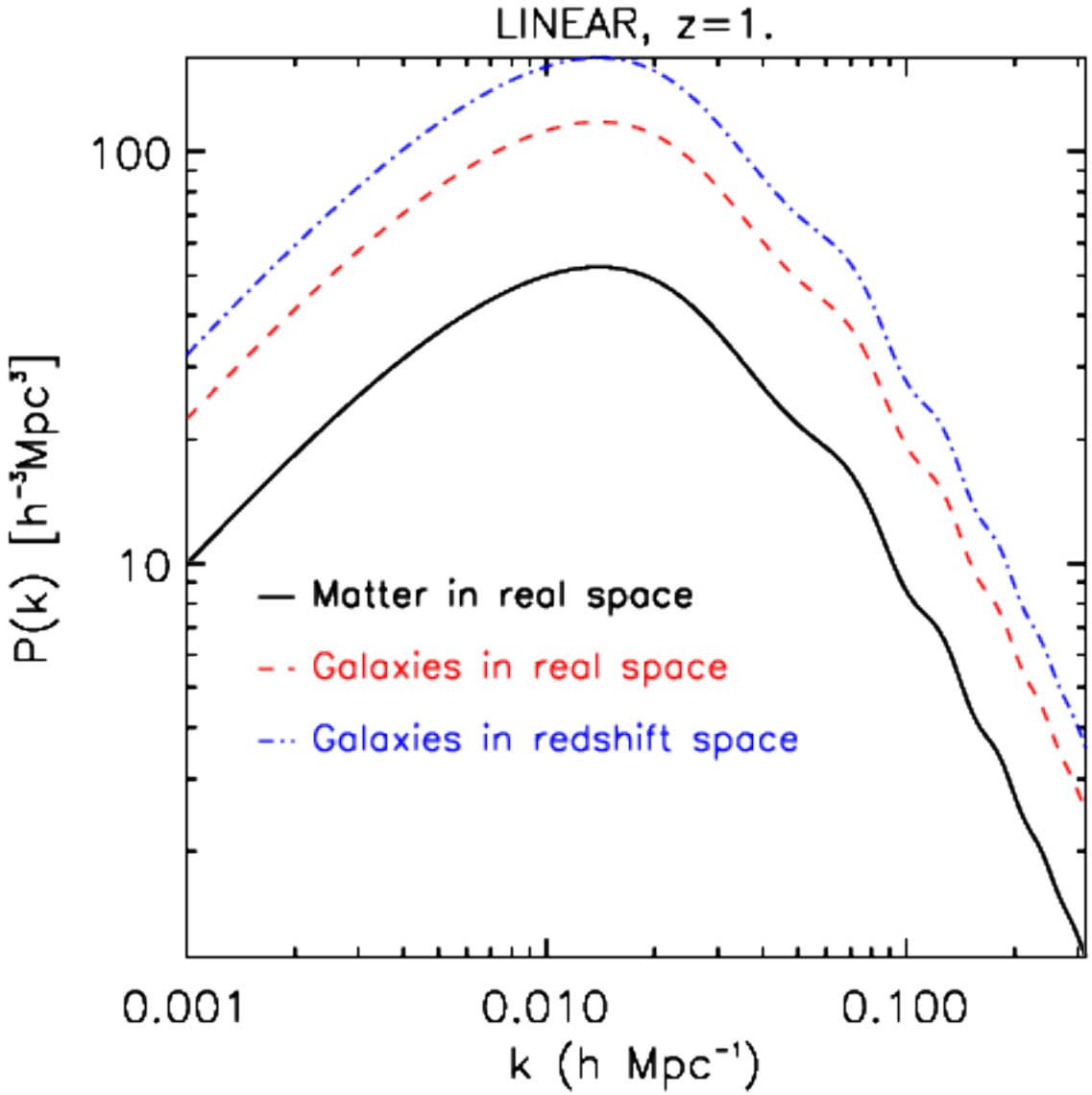


$$\delta_{g,R} = \sum_{i=0}^{N} \frac{b_i}{i!} \delta_R^i$$

Fry & Gaztañaga (1993)

The Matter power spectrum



$$\delta_{g,R} = \sum_{i=0}^{N} \frac{b_i}{i!} \delta_R^i$$

Fry & Gaztañaga (1993)

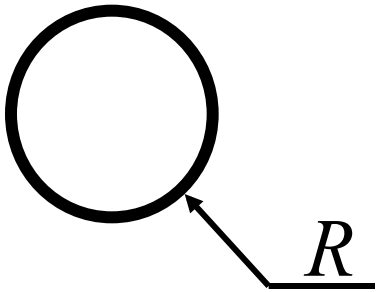
$$\delta_{g,R}{}^{z} = \delta_{g,R} + \mu_k{}^2 f^2 \delta_R$$

Kaiser (1987)

Estimator of the galaxy clustering

Variance of fluctuations in spheres:

$$\sigma^2_{g,R} = \left\langle {\delta_{g,R}}^2(\vec{x}) \right\rangle$$



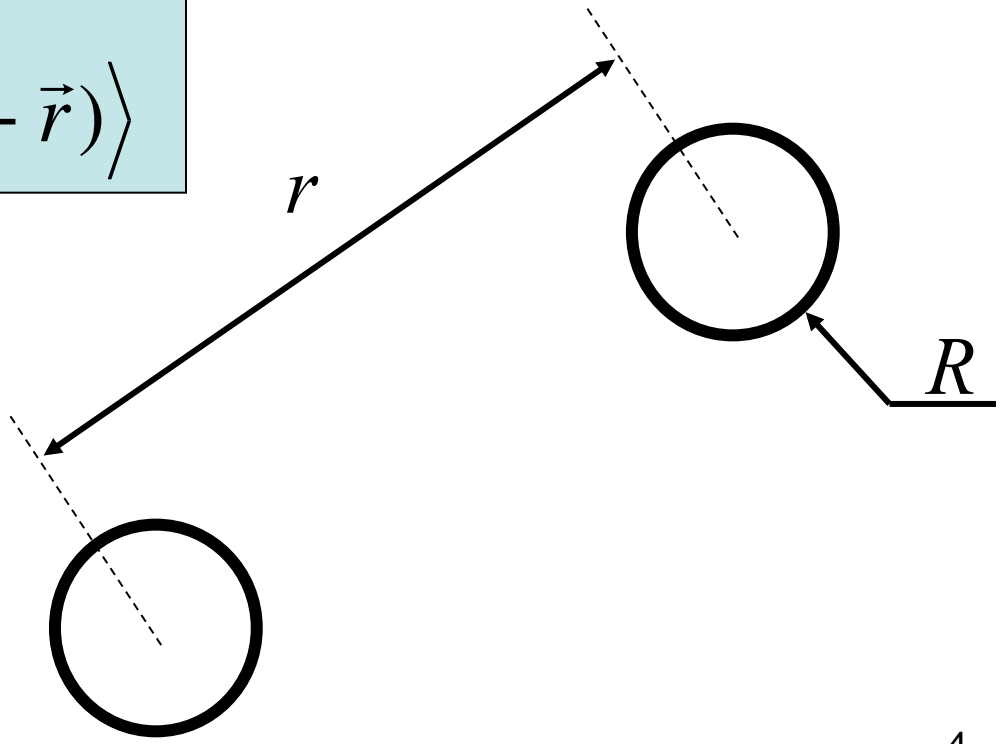
Estimator of the galaxy clustering

Variance of fluctuations in spheres:

$$\sigma^2_{g,R} = \left\langle {\delta_{g,R}}^2(\vec{x}) \right\rangle$$

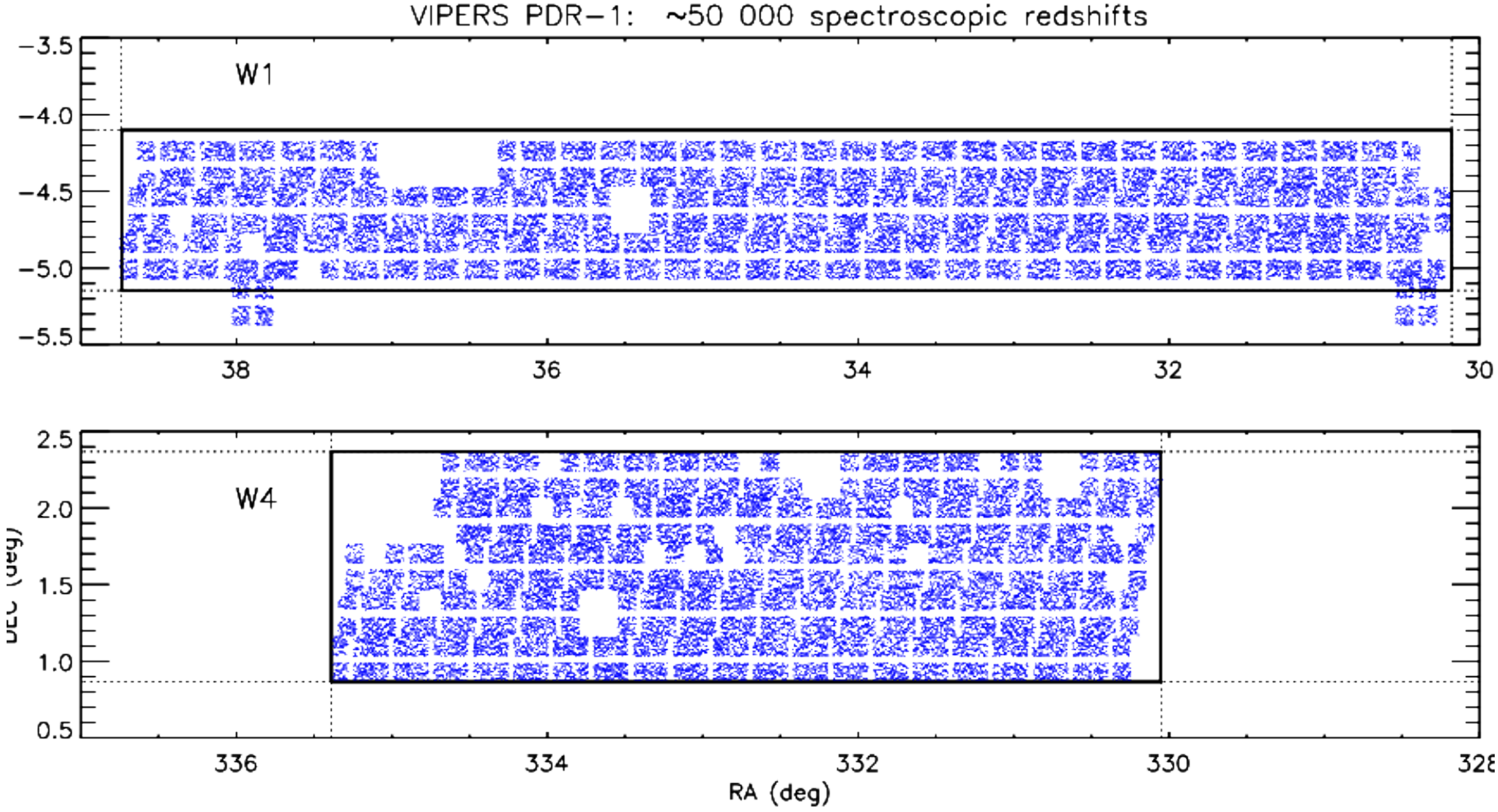
2-point correlation function:

$$\xi_{g,R}(r) = \left\langle \delta_{g,R}(\vec{x})\delta_{g,R}(\vec{x}+\vec{r}) \right\rangle$$



Estimator of the galaxy clustering

The **VI**mos **P**ublic **E**xtra-galactic **R**edshift **S**urvey: $0.5 \leq z \leq 1.2$



Guzzo et al. (the VIPERS team) 2014, A&A, submitted [arXiv:1303.2623]

Estimator of the galaxy clustering

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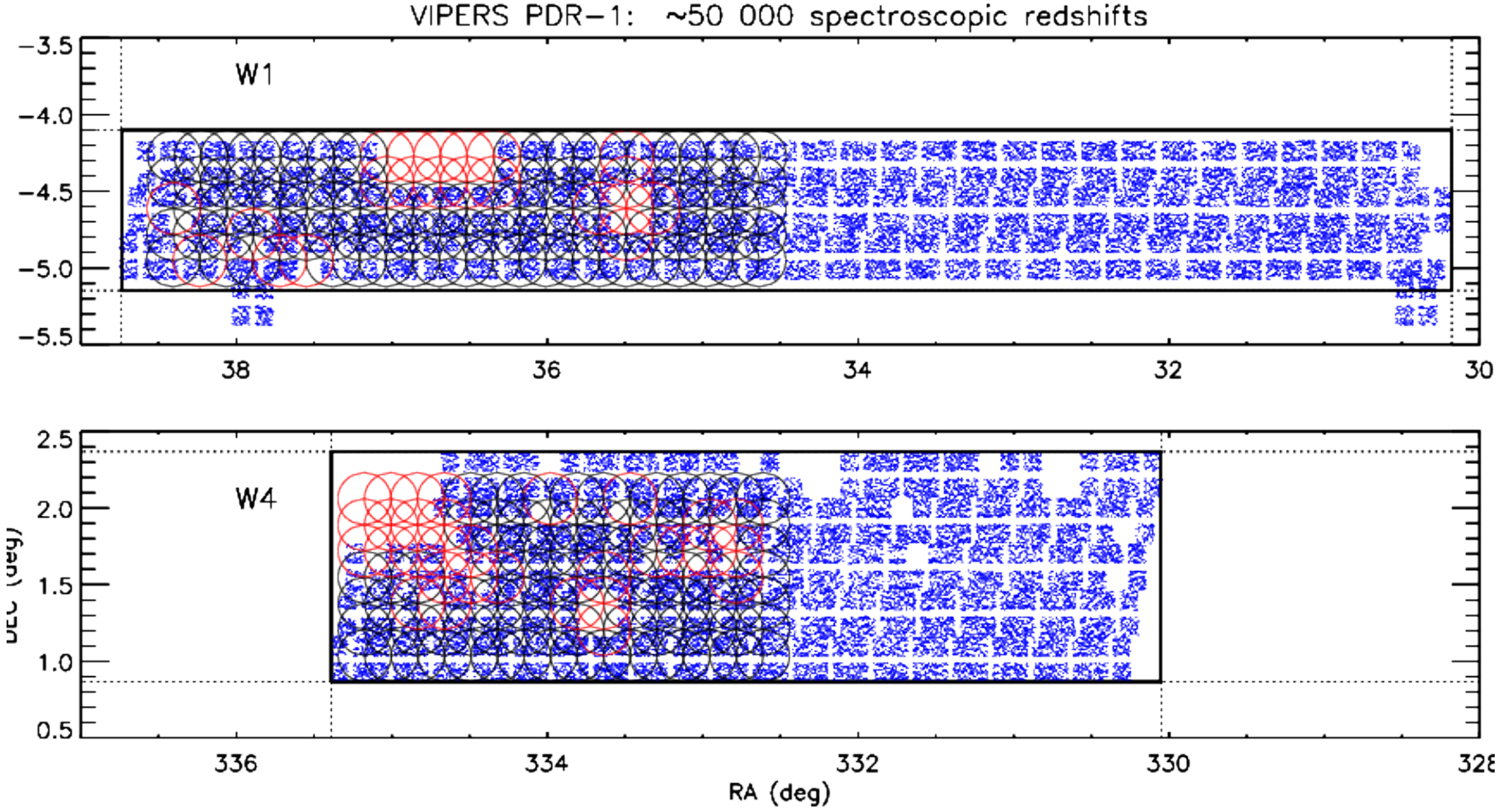

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Estimator of the galaxy clustering

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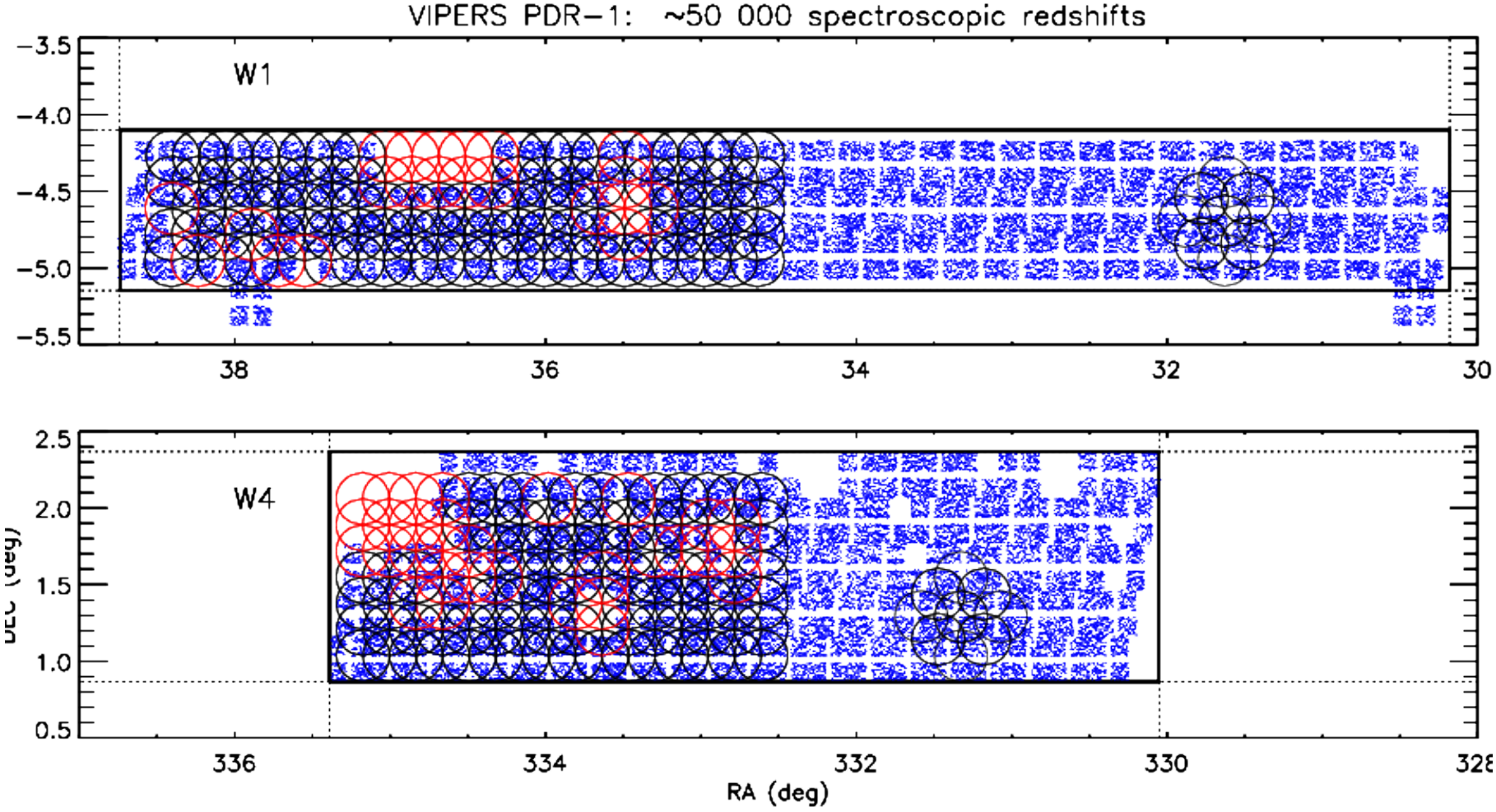

Guzzo et al. (the VIPERS team) 2014, A&A, submitted [arXiv:1303.2623]

The clustering ratio

The galaxy clustering ratio:

$$\eta_{g,R}(r) \equiv \frac{\xi_{g,R}(r)}{\sigma^2_{g,R}}$$

The matter clustering ratio:

$$\eta_R(r) = F_R\left(P(k), r\right)$$

In the large separation limit $(R << r)$ it reduces to:

$$\boxed{\eta^z_{g,R}(r) = \eta_R(r)}$$

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What you see (clustering of galaxies) is what you get (clustering of matter)

The clustering ratio

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$$\eta_{g,R}(r) \equiv \frac{\xi_{g,R}(r)}{\sigma^2_{g,R}}$$

The matter clustering ratio:

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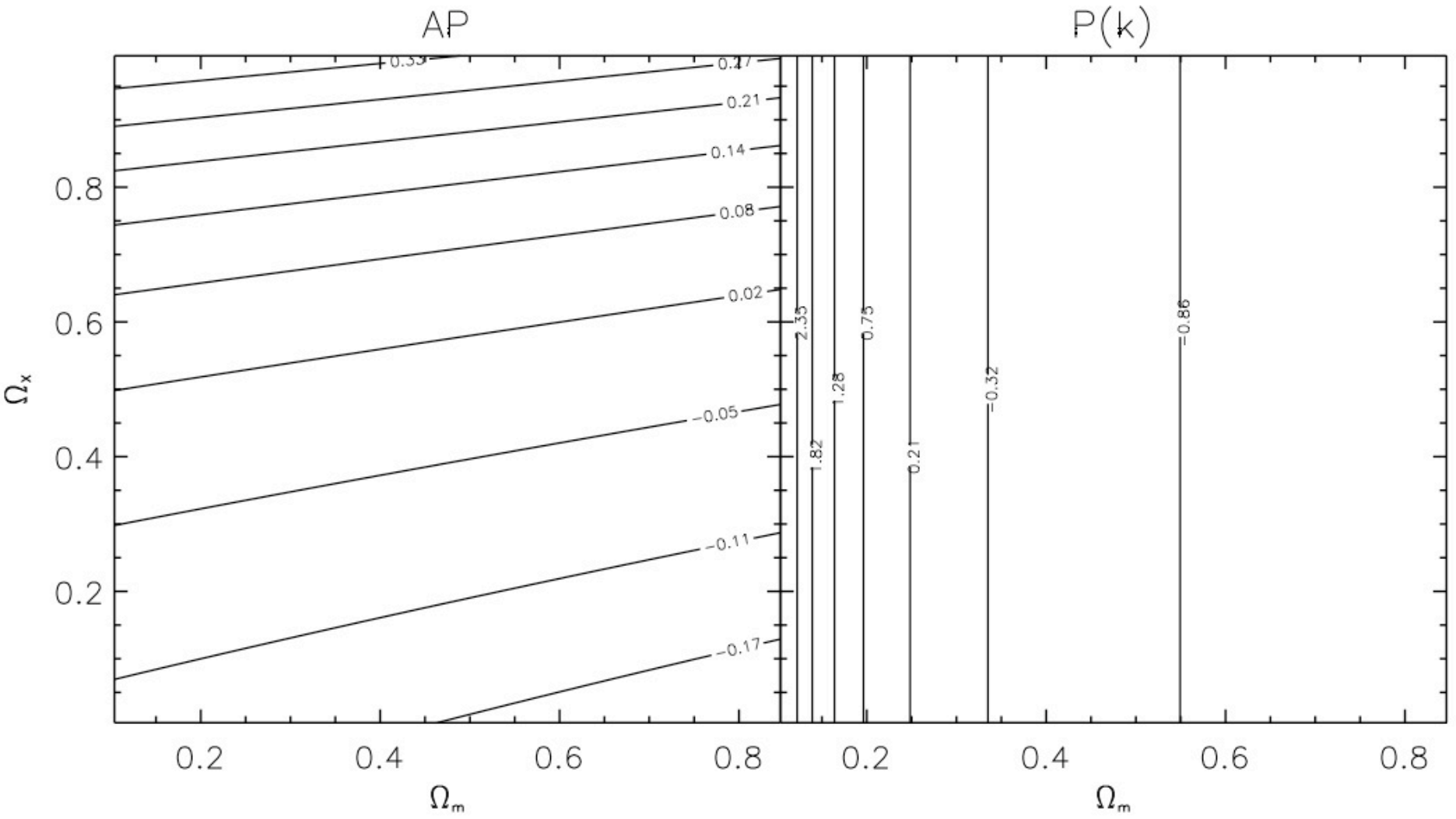
Alcock-Paczynski

Power spectrum

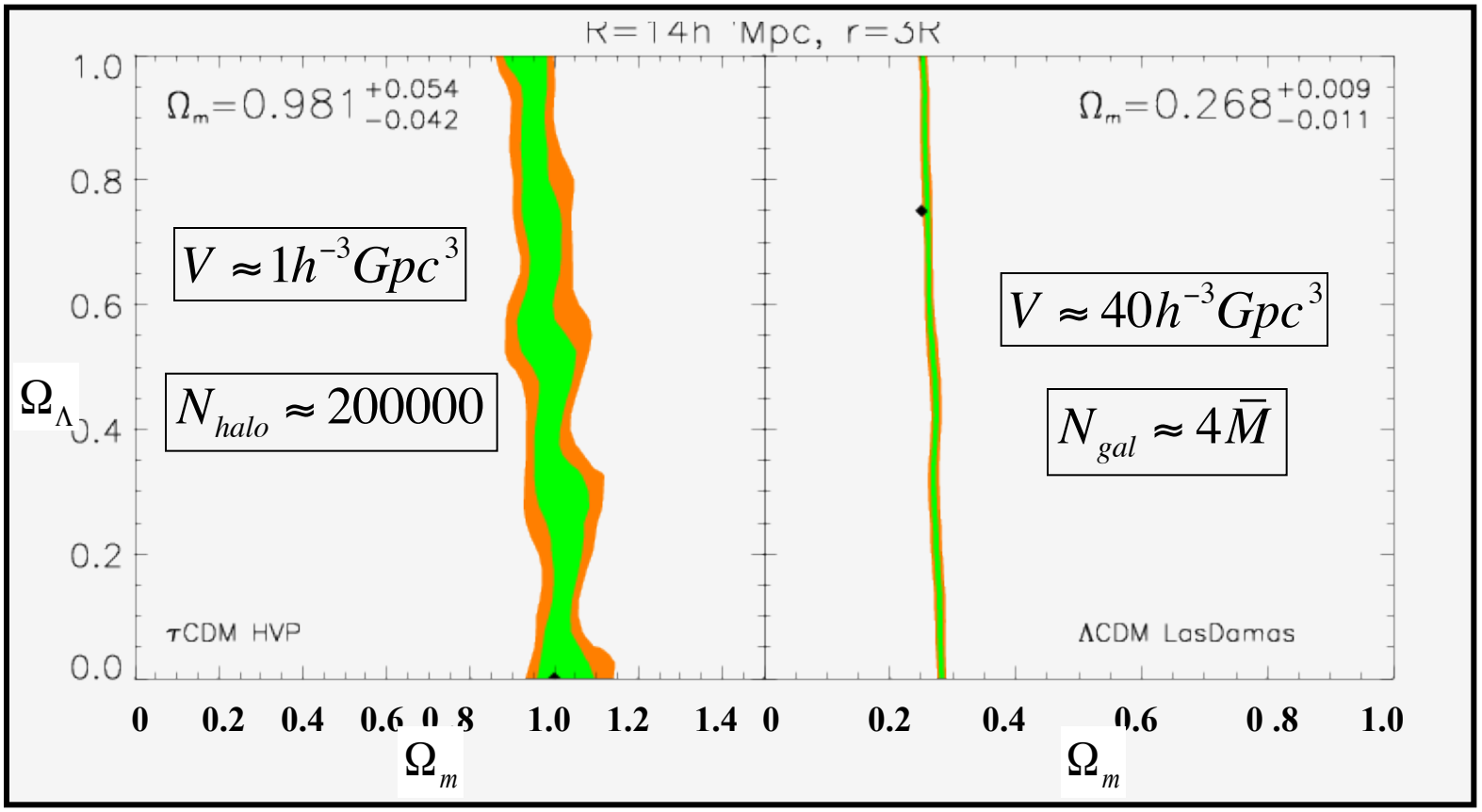
The clustering ratio



$$\eta^{z}_{g,R}(r,\vec{\Omega})/\eta^{z}_{g,R}(r,\vec{\Omega}_{true})-1$$

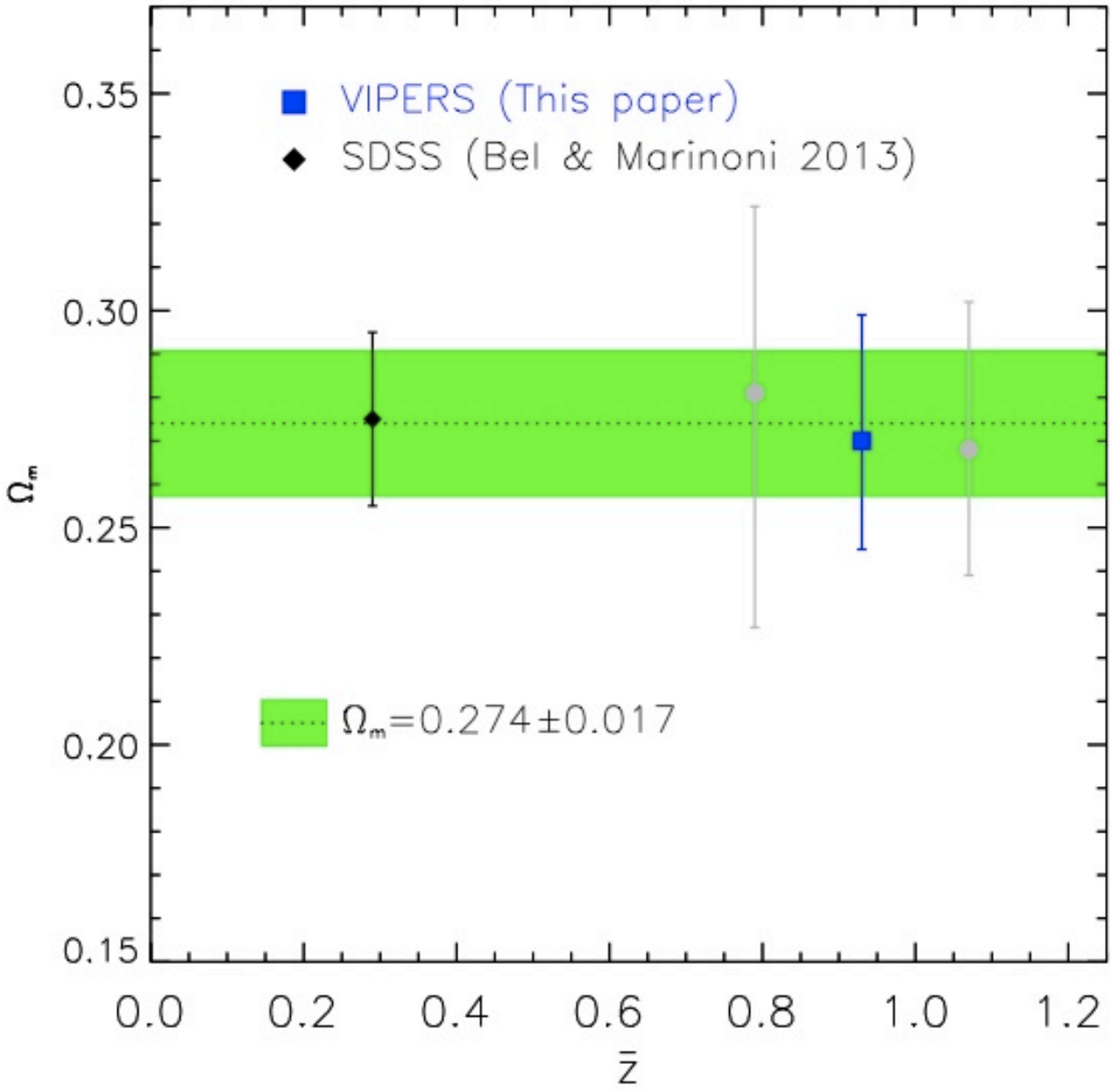
$$\eta_{R}(r,\vec{\Omega})/\eta_{R}(r,\vec{\Omega}_{true})-1$$

“Blind test” of N-body simulations: Figuring out the hidden cosmology



$$\begin{cases} h = 0.21 \\ \Omega_\Lambda = 0 \\ \Omega_m = 1 \\ \Omega_b = 0 \end{cases} \qquad \begin{cases} h = 0.70 \\ \Omega_\Lambda = 0.75 \\ \Omega_m = 0.25 \\ \Omega_b = 0.04 \end{cases}$$

SDSS DR7 + VIPERS PDR1



Planck

Conclusions

- A new clustering statistic: the galaxy clustering ratio $\eta_R = \frac{\xi_R}{\sigma_R}$

  - Its amplitude is the same for galaxies and matter (on linear scales)

  - It is independent of linear redshift distortions

  - The estimator is simple (count-in-cell) and robust (blind analysis on NON LCDM cosmology)

- Assuming a flat LambdaCDM universe and combining VIPERS and SDSS measurements

$$\Omega_m = 0.274 \pm 0.017$$

- Next: include massive neutrinos and help constraining their mass

Statistical properties of smoothed over-densities

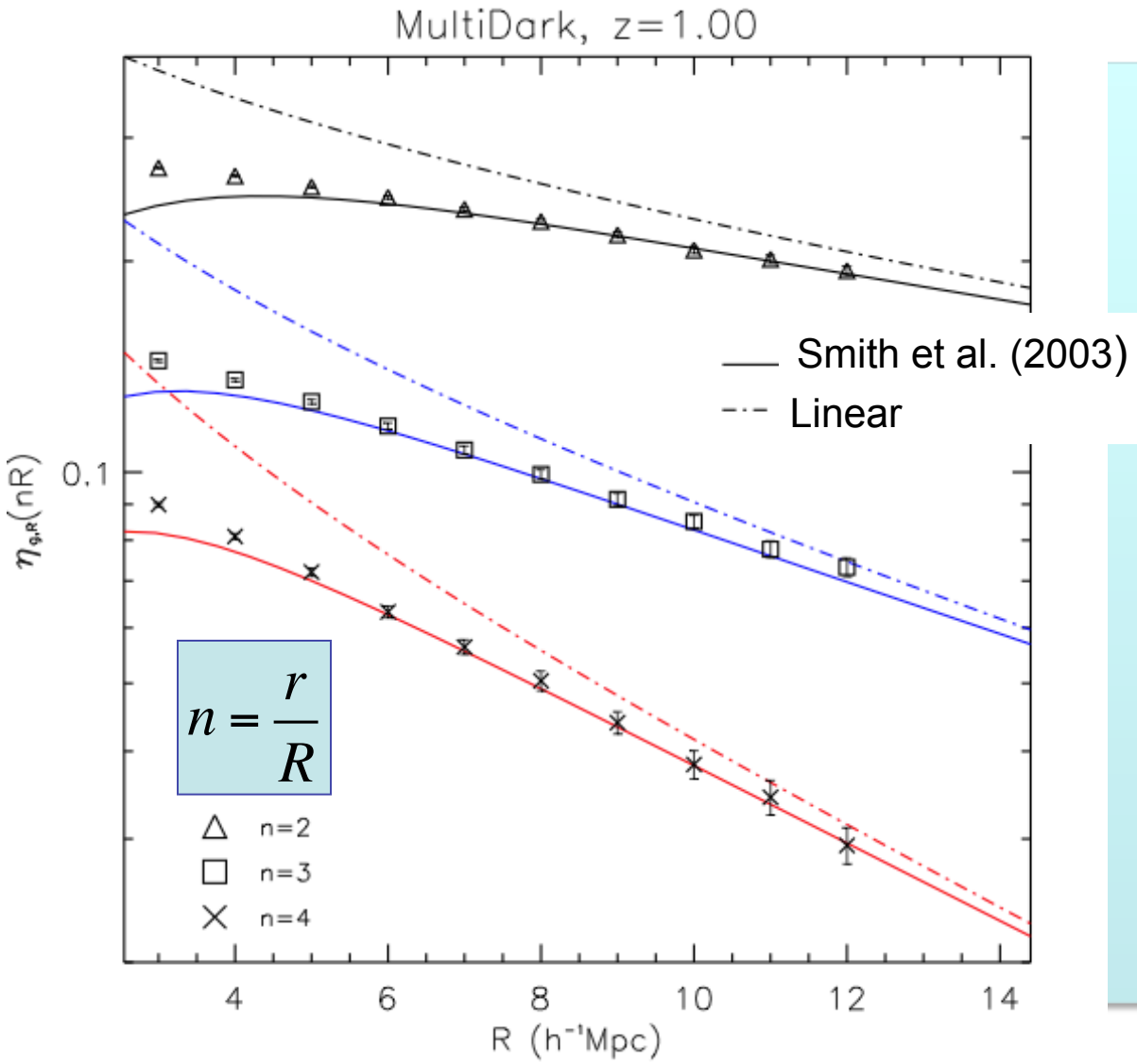
variance of smoothed matter field: $\sigma_R^2(z) = g^2(z).\sigma_8^2(0).F_R$

2-point correlation function of smoothed matter field: $\xi_R(r,z) = g^2(z).\sigma_8^2(0).G_R(r)$

$$F_R = \frac{\int_0^{+\infty} \Delta_k W_{TH}^2(kR)\, d\ln k}{\int_0^{+\infty} \Delta_k W_{TH}^2(kr_8)\, d\ln k} \quad \text{and} \quad G_R(r) = \frac{\int_0^{+\infty} \Delta_k(z) W_{TH}^2(kR)\, j_0(kr)\, d\ln k}{\int_0^{+\infty} \Delta_k(z) W_{TH}^2(kr_8)\, d\ln k}$$

- **Redshift evolution**
- **Non linear bias**
- **Redshift distortions**

The clustering ratio in the weakly non linear regime

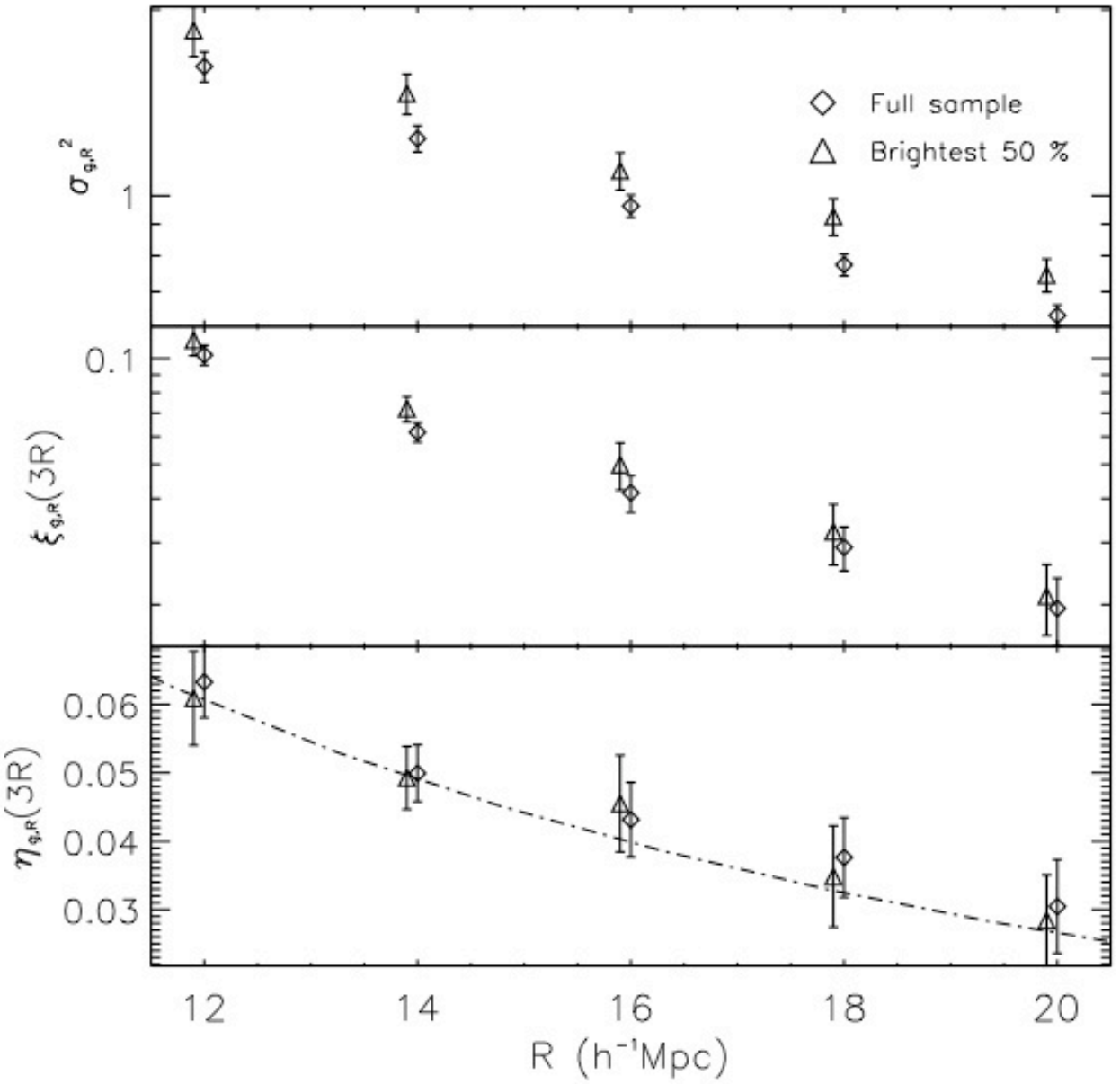


1 h^{-3} Gpc^3 comoving output at z=1 of MultiDark simulation

(Prada et al. 2012)

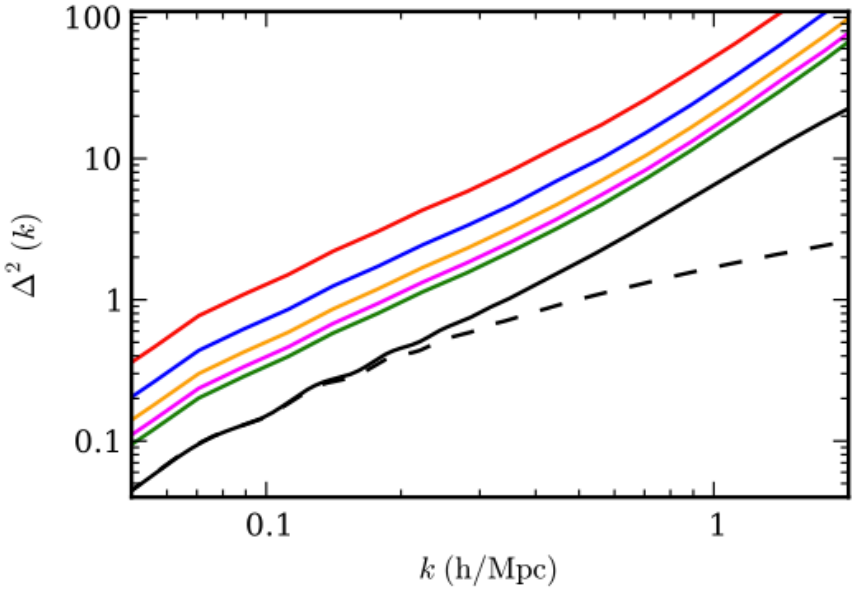
14 millions of Haloes with masses between $10^{11.5}$ h^{-1} and $10^{14.5}$ h^{-1} solar masses

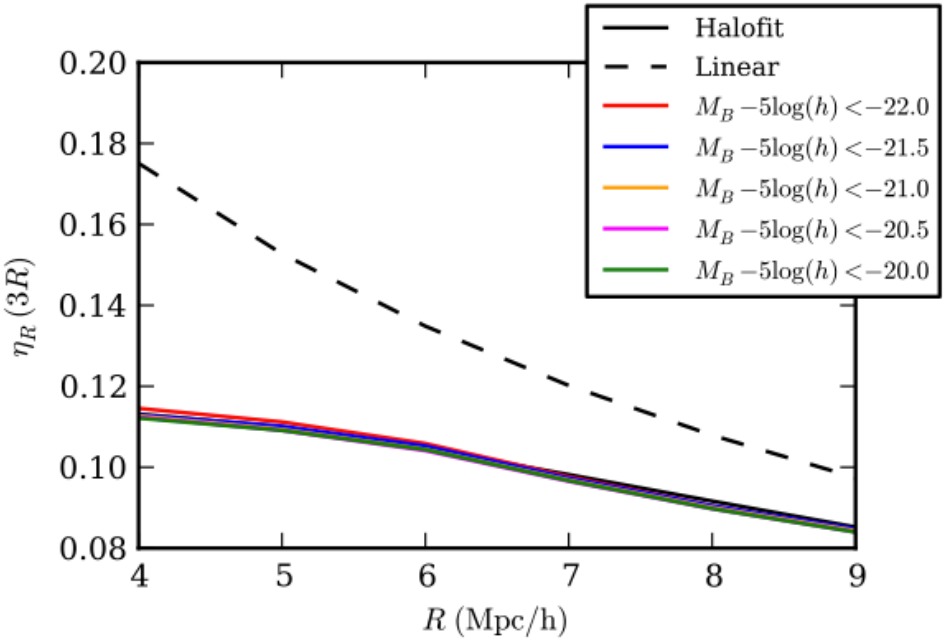
Luminosity


Full sample
Brightest 50 %
$\sigma^2_{g,R}$
1
0.1
$\xi_{g,R}(3R)$
0.06
0.05
0.04
0.03
$\eta_{g,R}(3R)$
12
14
16
18
20
R (h^{-1}Mpc)

The clustering ratio Vs Galaxy bias

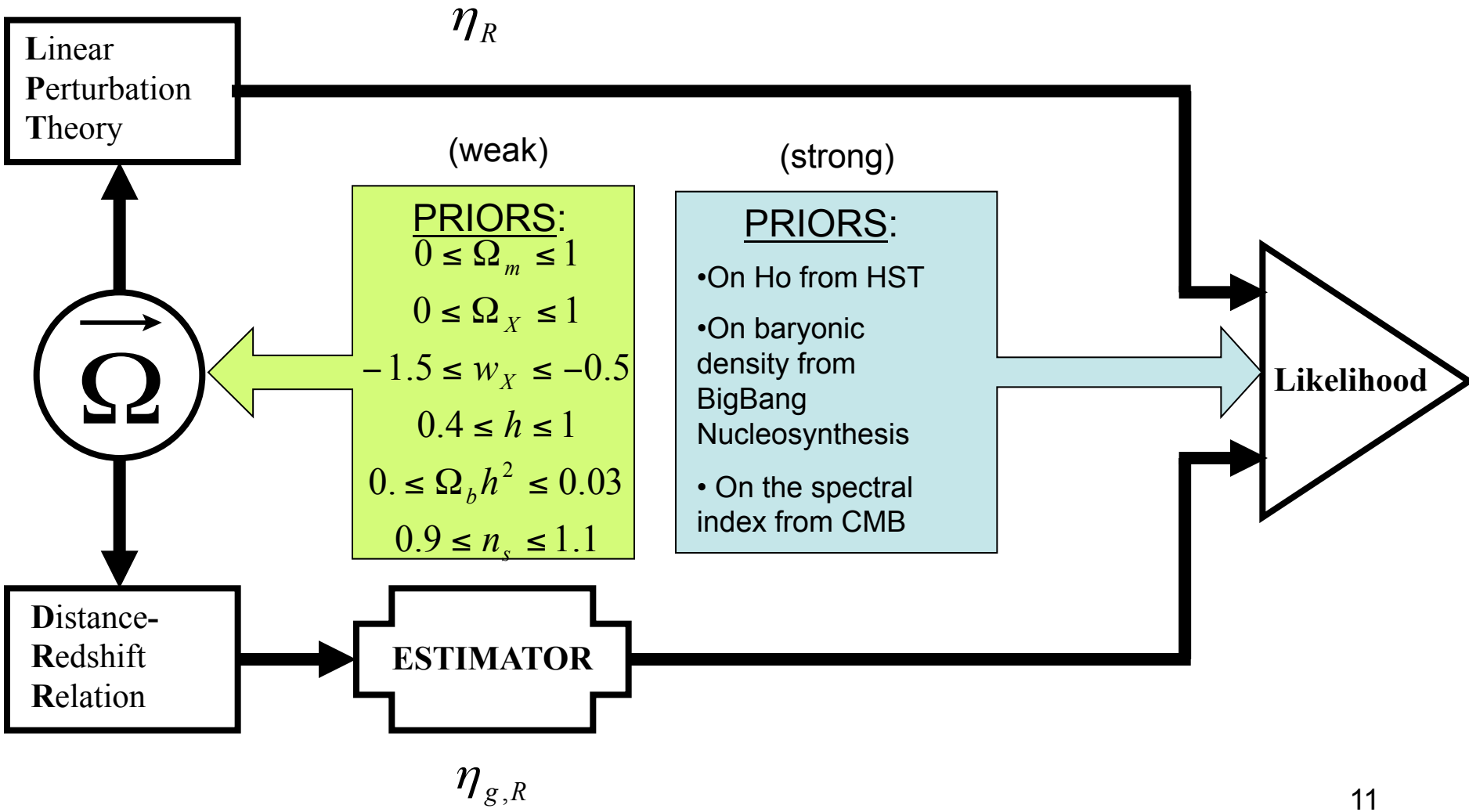
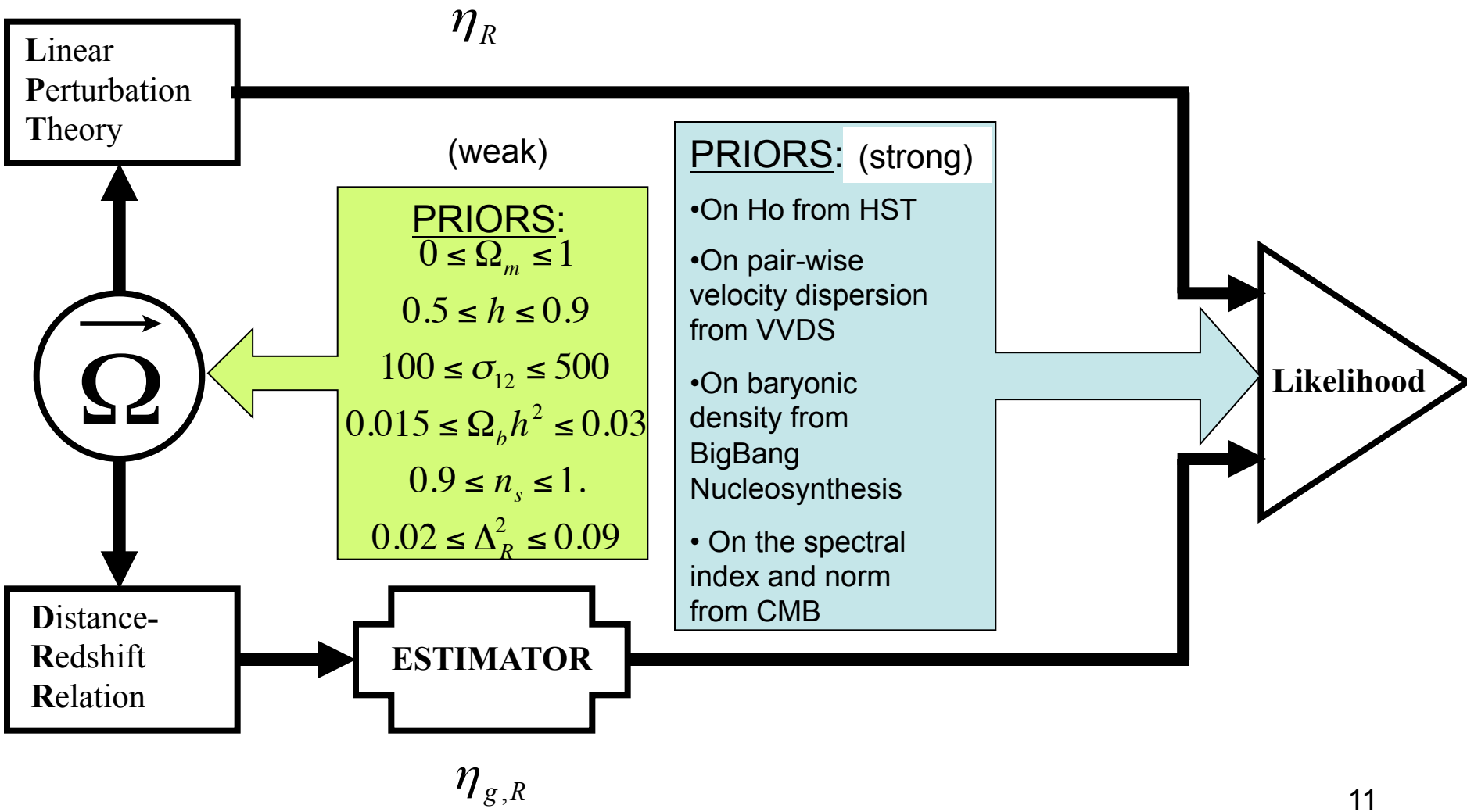
Impact of scale dependent bias:





Analysis performed on HOD galaxy mock catalogues described in de la Torre et al. (2013)

Application of the strategy (SDSS)



Application of the strategy (VIPERS)