THE UNIVERSITY of EDINBURGH

Combining redshift-space distortions with lensing

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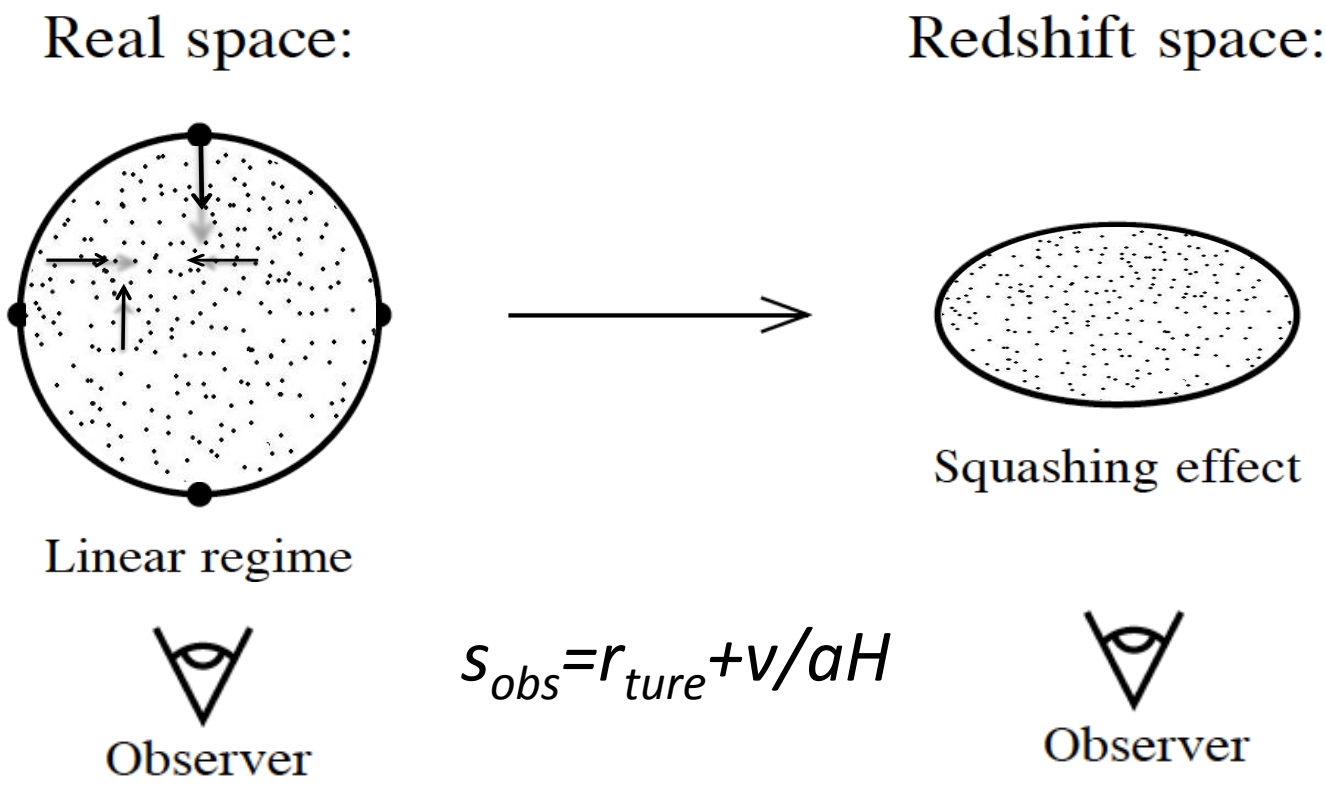
THE ROYAL SOCIETY

Mock Córdoba
Córdoba, 09 April, 2019

Redshift Space Distortion (RSD)



Hamliton 1997

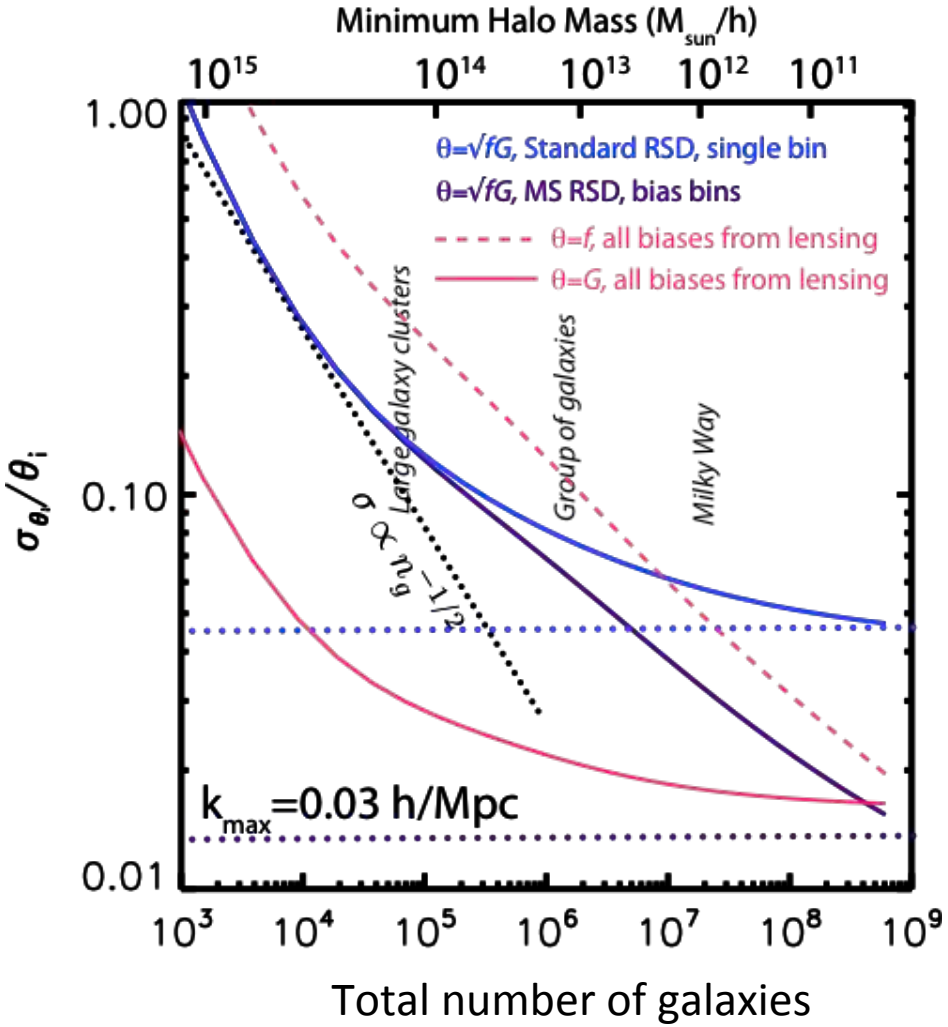
Limits of standard RSD:

$$P_s = (b + f\mu^2)^2 P = (b/f + \mu^2)^2 f^2 P$$

- *f* is degenerate with *b*, only constrain f^2P & b/f
- Linear RSD valid only on very large scales
- Sample Variance limited:

$$\sigma_{\ln fG} \geq \sqrt{\frac{11}{N_s}}$$

Constraints with known bias

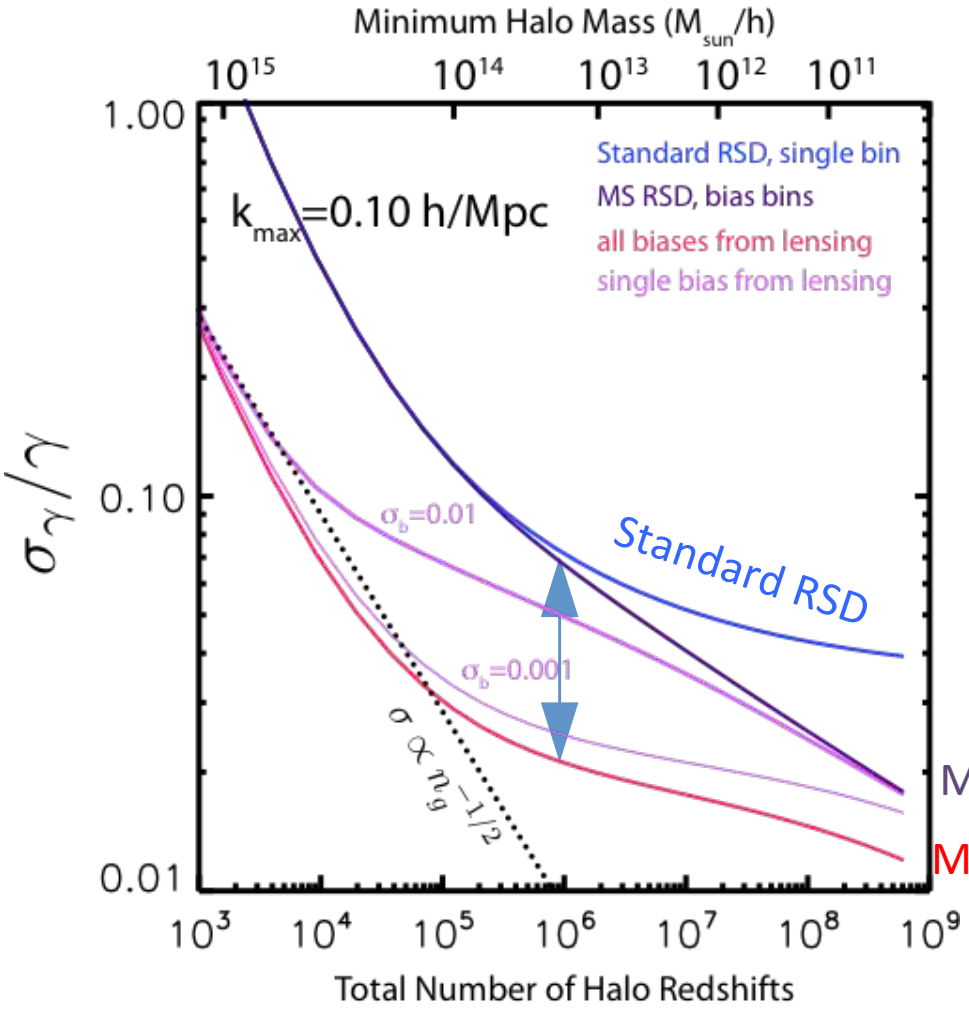


- Multi-tracer RSD helps
- Need high accuracy in measuring b

MacDonald & Seljak (2009)
Bernstein & Cai 2011
Cai & Bernstein 2012

Constraints on gravity

$$f(a) \approx \Omega_m^{\gamma}(a)$$



Need high accuracy in measuring b

A very deep spec-z survey can be close to the optimal, without knowing the bias

Bernstein & Cai 2011
Cai & Bernstein 2012

Multi-tracer RSD

Multi-tracer RSD + bias

Knowing bias+RSD is like having 10 Universes to measure

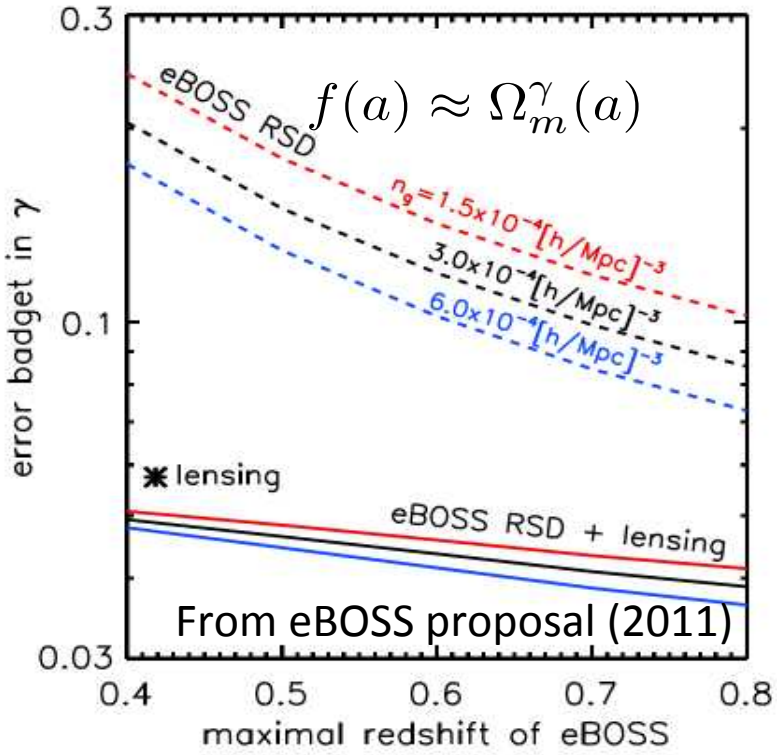
Beyond Standard RSD

- Limitations –

1. Cosmic variance

2. b-f degeneracy

3. bias stochasticity



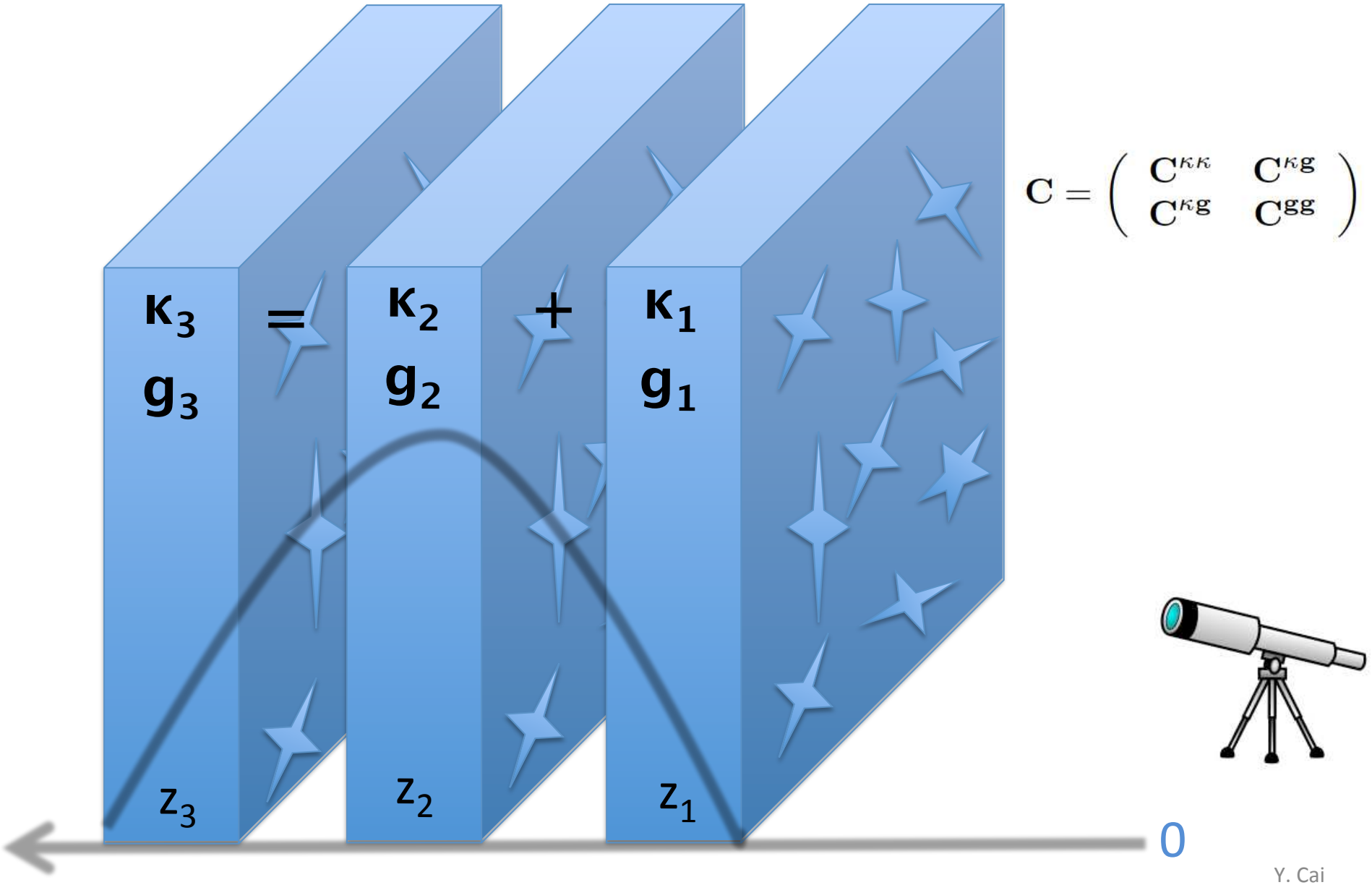
- Improvements –

1. Multi-tracer RSD

2. Combine lensing survey with spec-z survey

3. Optimal weighting of halos/galaxies

Shear-galaxy cross-correlation



$$\mathbf{C} = \begin{pmatrix} \mathbf{C}^{\kappa\kappa} & \mathbf{C}^{\kappa g} \\ \mathbf{C}^{\kappa g} & \mathbf{C}^{gg} \end{pmatrix}$$

Y. Cai

$$\mathbf{C} = \begin{pmatrix} \mathbf{C}^{\kappa\kappa} & \mathbf{C}^{\kappa g} \\ \mathbf{C}^{\kappa g} & \mathbf{C}^{gg} \end{pmatrix}$$

$$C_{ij}^{\kappa\kappa}(l) = \sum_{k=1}^{min\{i,j\}-1} A_{ik}A_{jk}\Delta\chi_k P_k(l)F_k^2 + \sigma_\epsilon^2/(n_i\delta_{ij})\,|_{i,j\geq 2}$$

$$C_{ij}^{gg}(l) = D_i^{-2}\Delta\chi_i^{-1}P_i(l)b_i^2(1+E_i^2)\delta_{ij}$$ (from spec-z survey)

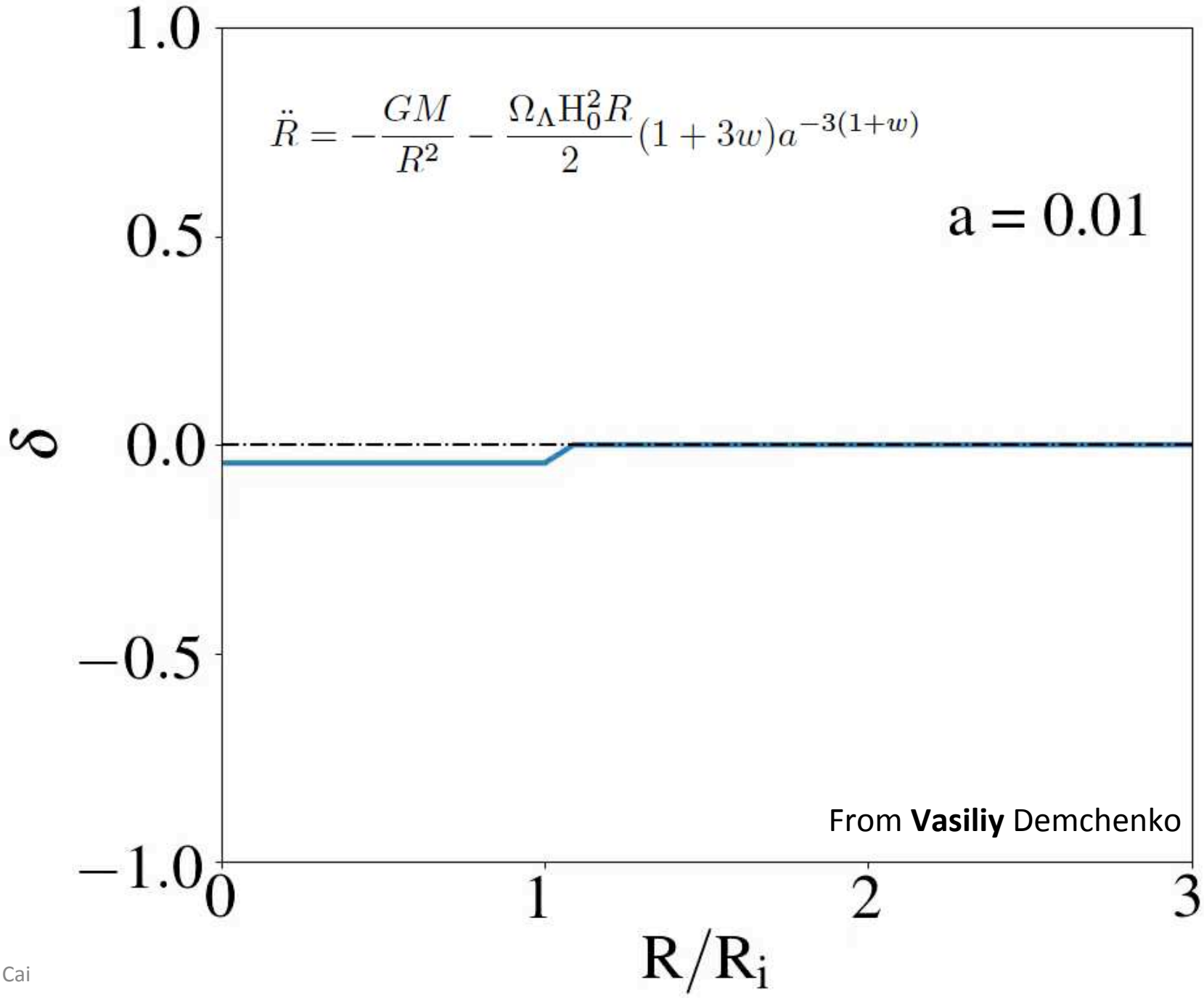
$$C_{ij}^{\kappa g}(l) = A_{ji}D_i^{-1}P_i(l)b_iF_i\;|_{1\leq i<j}$$

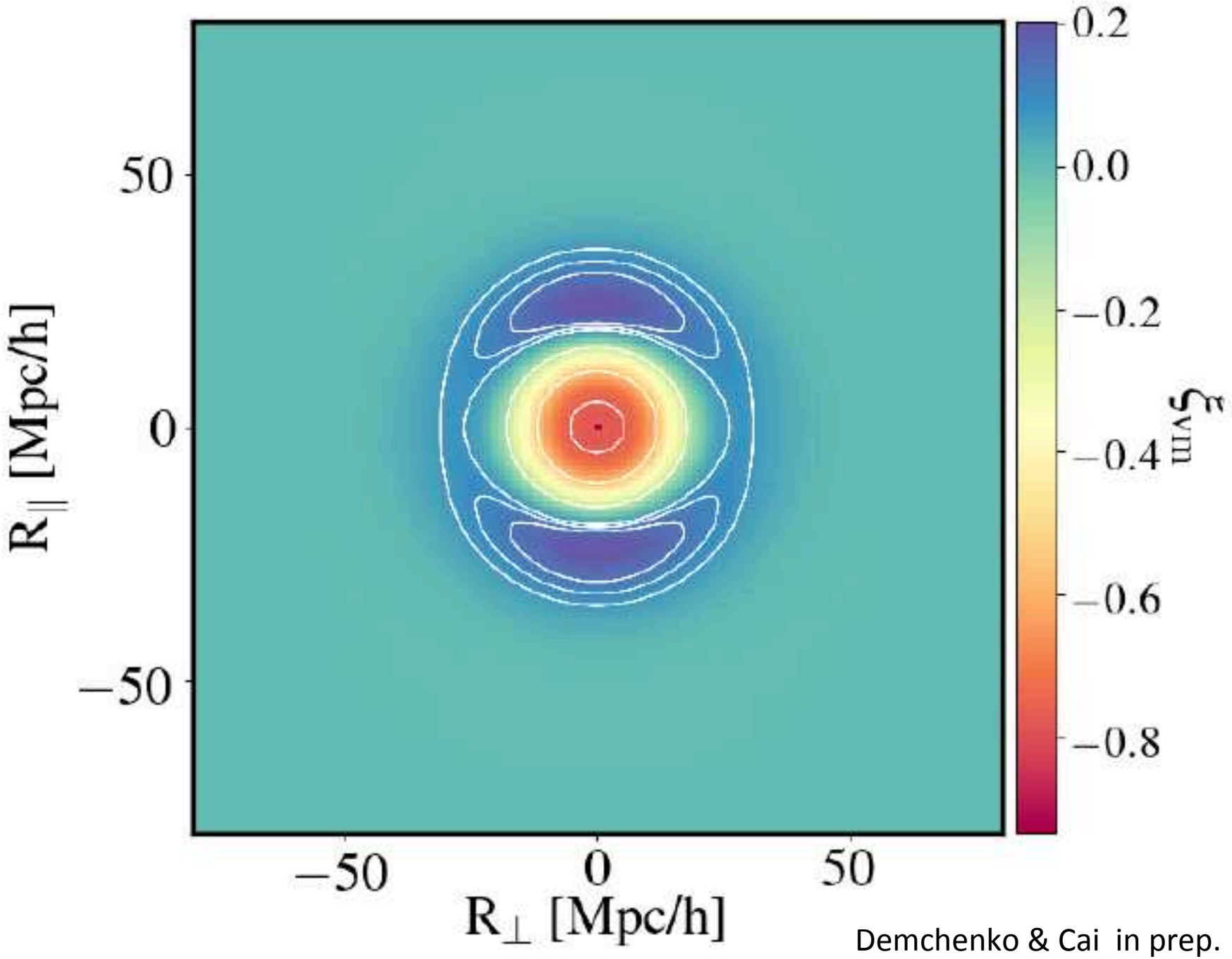
Parameters: P, b, E

Lensing tomography gives constraints on P_m and b

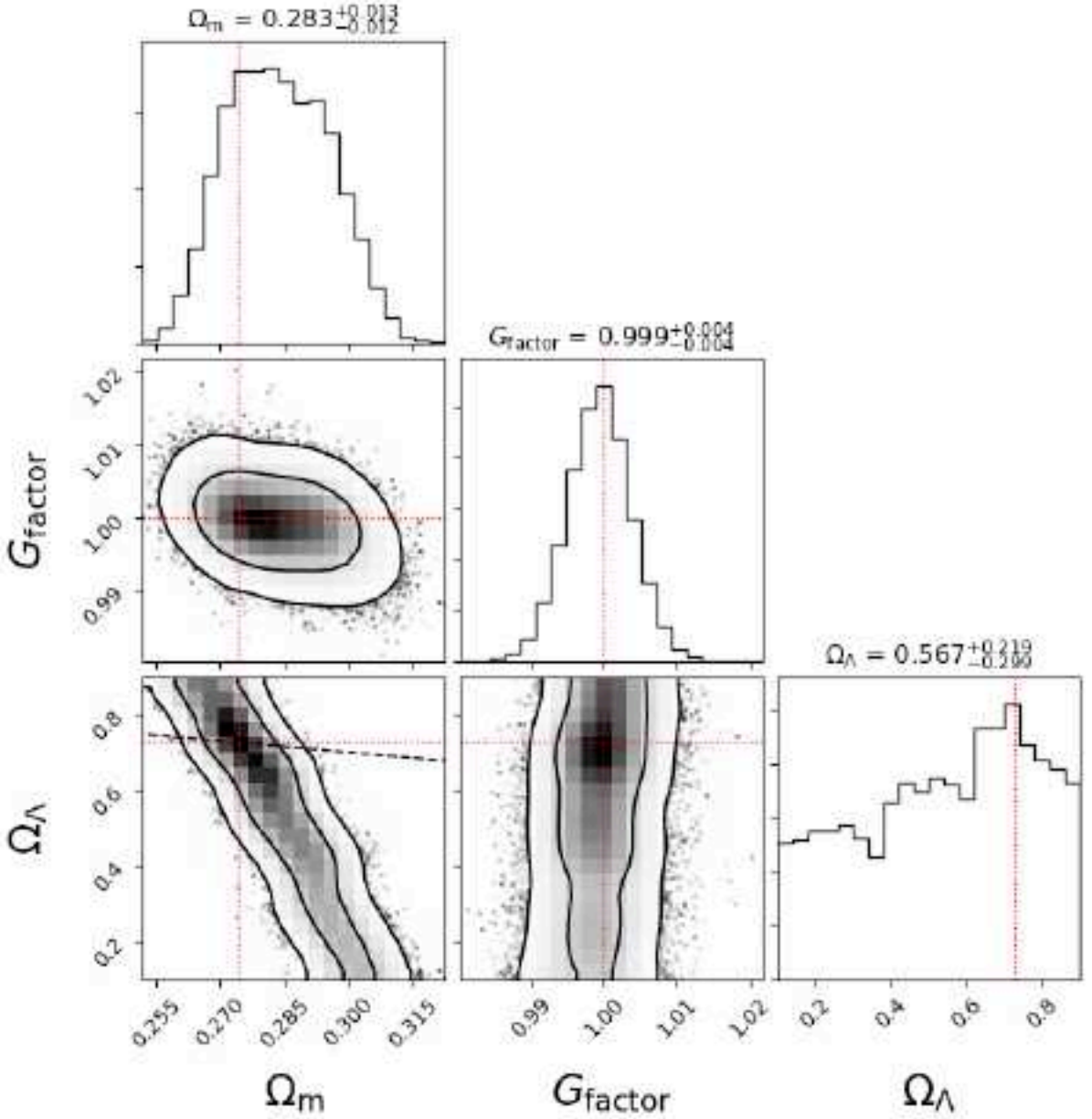
Cai & Bernstein 2012; Gaztañaga et al, 2012; Kirk et al. 2015
Eriksen & Gaztañaga 2015a,b,c, 2018;

Modelling RSD+lensing

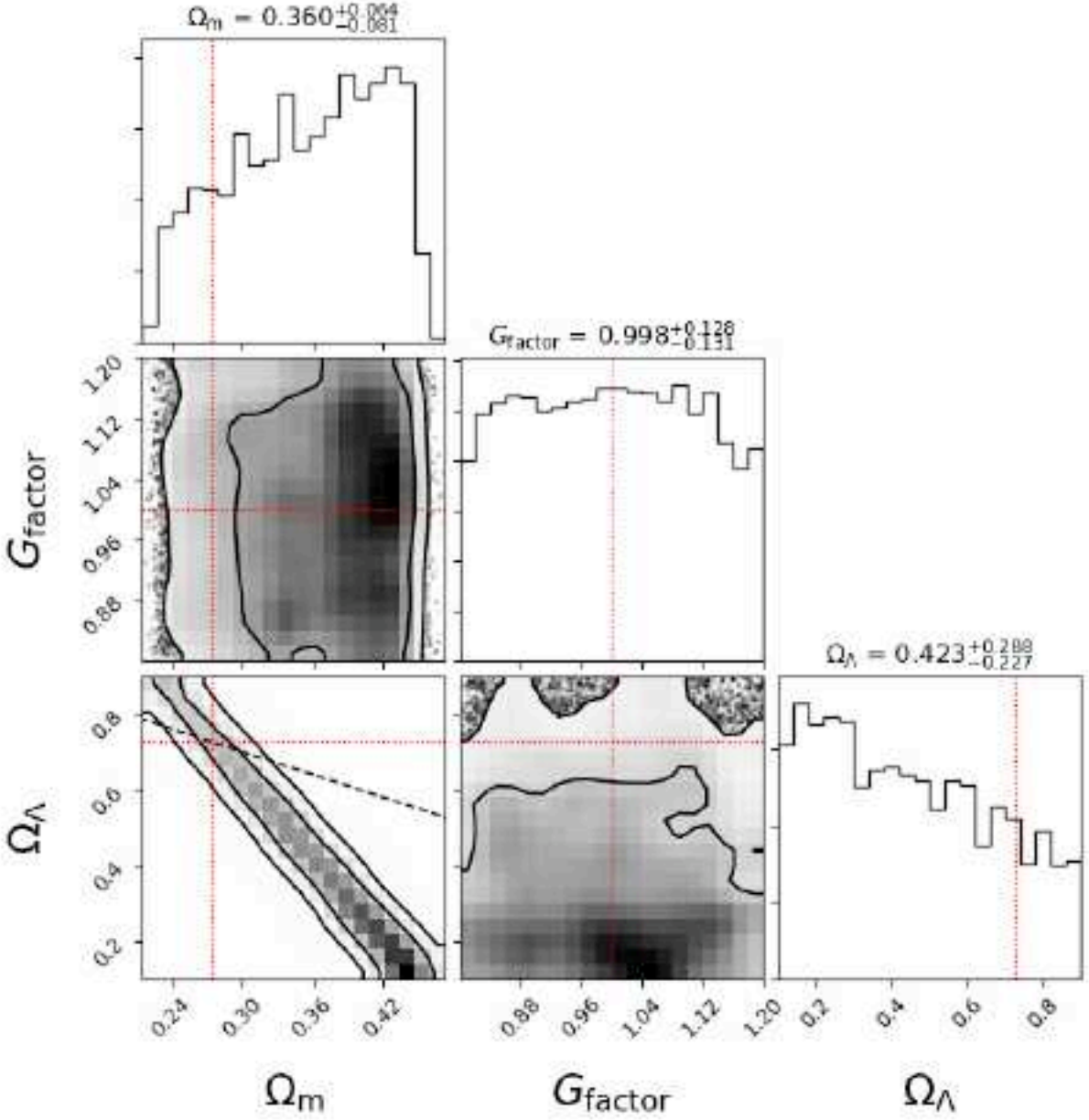

$\ddot{R} = -\frac{GM}{R^2} - \frac{\Omega_\Lambda H_0^2 R}{2}(1+3w)a^{-3(1+w)}$
a = 0.01
δ
1.0
0.5
0.0
−0.5
−1.0
0
1
2
3
R/R_i
From **Vasiliy** Demchenko



Demchenko & Cai in prep.



Demchenko & Cai in prep.



Demchenko & Cai in prep.

What mocks are needed

- Particle data in the lightcone, shear catalogues
- Realistic galaxies in the lightcone
- Many of them

The Cosmic Web: From Galaxies to Cosmology

17 - 19 June 2019

Edinburgh

Confirmed speakers

Mehmet Alpaslan (NYU)
Miguel Aragon-Calvo (UNAM)
Sandrine Codis (IAP)
Bridget Falck (University of Oslo)
Oliver Hahn (OCA, Nice)
Xi Kang (Purple Mountain Observatory)
Florent Leclercq (ICIC, London)
Jounghun Lee (Seoul National University)
Christophe Pichon (IAP)
Dmitri Pogosyan (University of Alberta)
Cristiano Porciani (Bonn)
Sergei Shandarin (University of Kansas)
Ravi Sheth (UPenn)
Elmo Tempel (Tartu Observatory)
Rien van de Waygaert (Gröningen)
Charlotte Welker (CITA)

SOC

Shadab Alam (Edinburgh)
Yan-Chuan Cai (Edinburgh)
Joanne Cohn (UC Berkeley)
Katarina Kraljic (Edinburgh)
Avery Meiksin (Edinburgh)
John Peacock (Edinburgh)
Martin White (UC Berkeley)
Chirstophe Pichon (IAP)
Rien van de Waygaert (Gröningen)

LOC

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Katarina Kraljic
Avery Meiksin
John Peacock

COSFORM

NAM2019

National Astronomy Meeting 2019

Lancaster University: 30th June - 4th July 2019

Parallel sessions

https://nam2019.org

Topic	
Session title	**Cosmic Web**: Bridging Galaxies and Cosmology
Description	On large scales, the matter distribution of the Universe follows a web-like pattern, consisting of knot, filament, sheet and void. The cosmic-web contains invaluable information about cosmology and provides the environment for galaxy formation. It is the junction where cosmology and astrophysics meet. This session aims to address the following two questions: (1) What can we learn about cosmology from the cosmic web? (2) How is galaxy formation shaped by the cosmic web?
Organiser(s)	Y.-C. Cai, K. Kraljic, S. Alam, C. Duckworth
Status	Open for submission

Thank you!