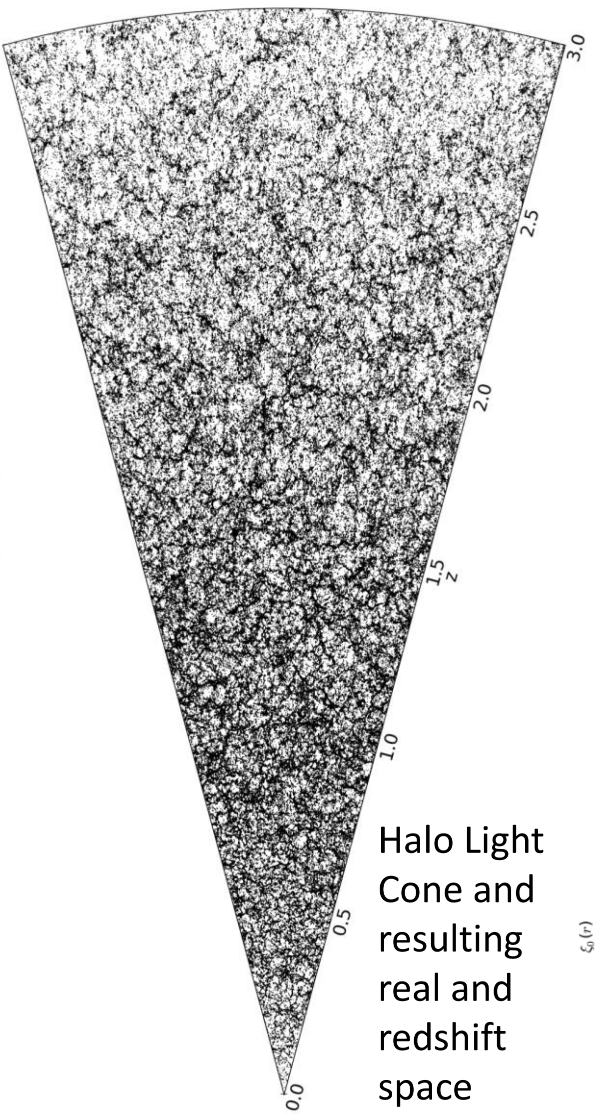
Large Scale Halo Light Cones

Shaun Cole, Alex Smith and Husni Almoubayyed
ICC, Durham



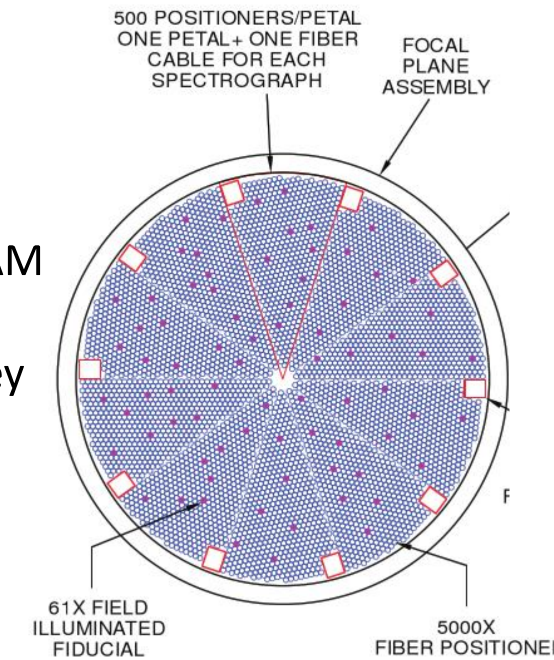
Halo Light Cone and resulting real and redshift space clustering

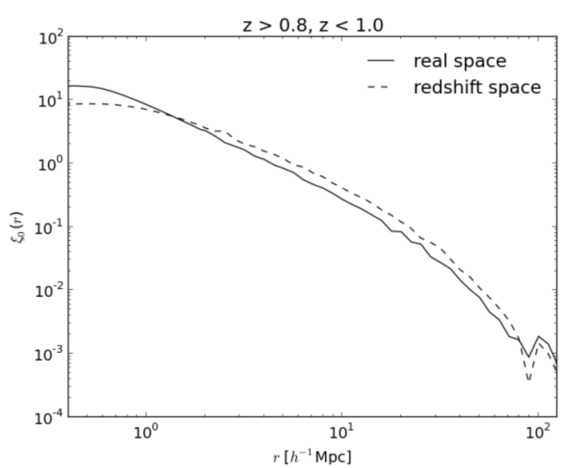
Subhalo merger trees from the 3 Gpc/h MXXL simulation used to construct halo lightcones with accurate clustering properties.

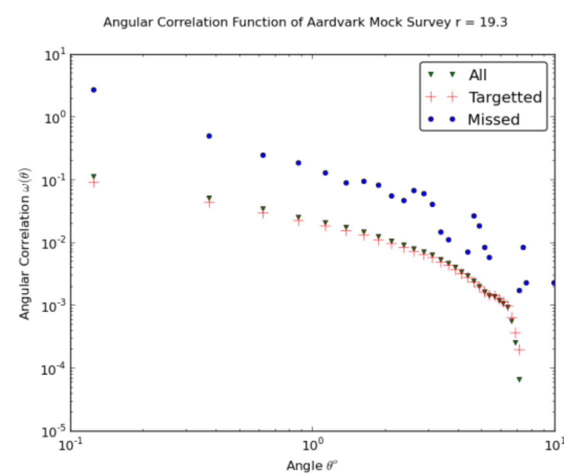
Can be populated with galaxies using HOD or SHAM

Example App: Design of DESI Bright Galaxy Survey (~10 million galaxies to r=~19.5)

Impact of fibre placement constraints on the clustering of targeted galaxies and development and testing of methods of mitigation.





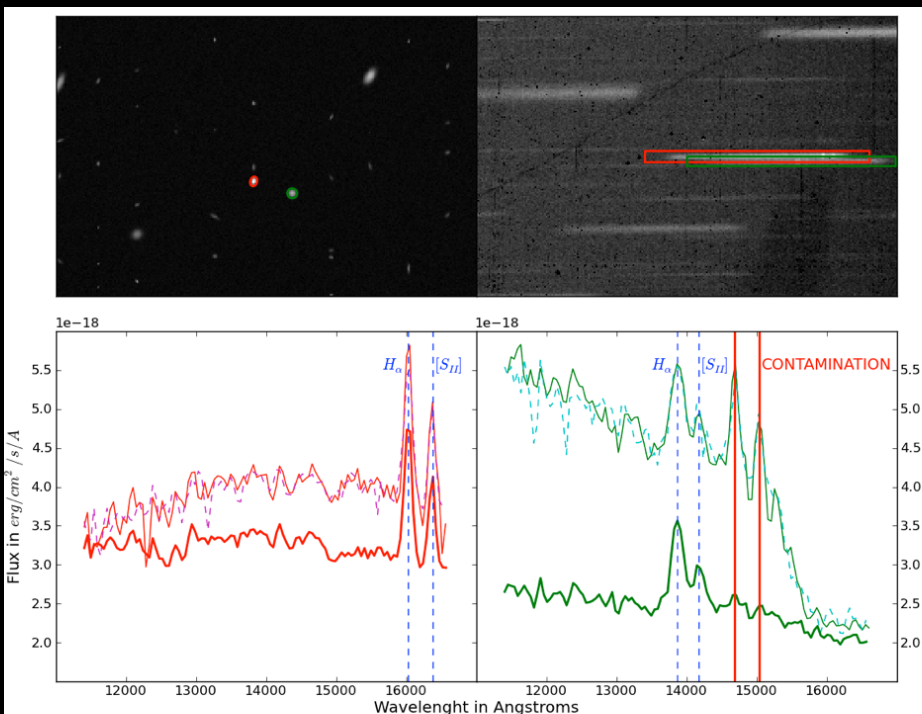


Fibres in the DESI focal plane and the effect on angular clustering

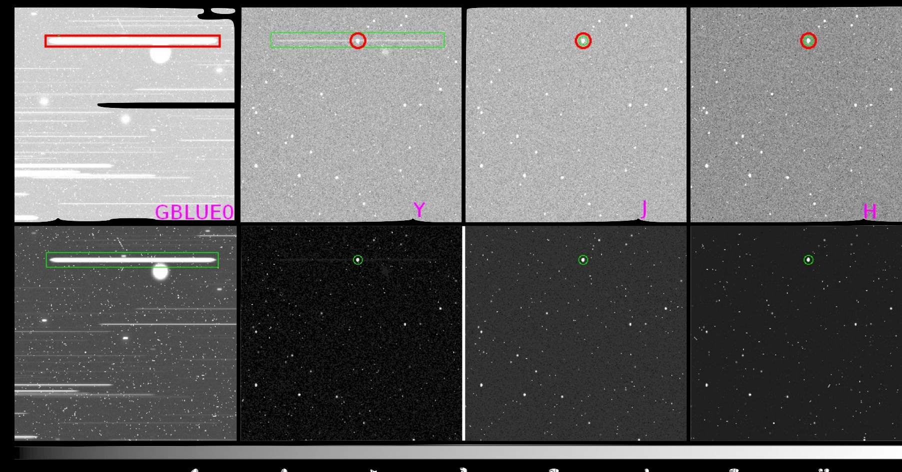
Simulating Spectroscopic Data for Euclid Galaxy Clustering

Katarina (Dida) Markovic, ICG Portsmouth, UK

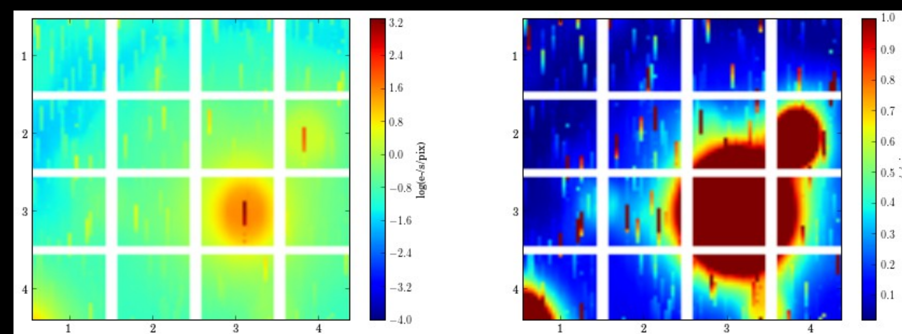
- Euclid:
  - 10s of millions of spec-z
  - slitless spectroscopy



- contamination of adjacent spectra



- contamination by noise effects: persistence



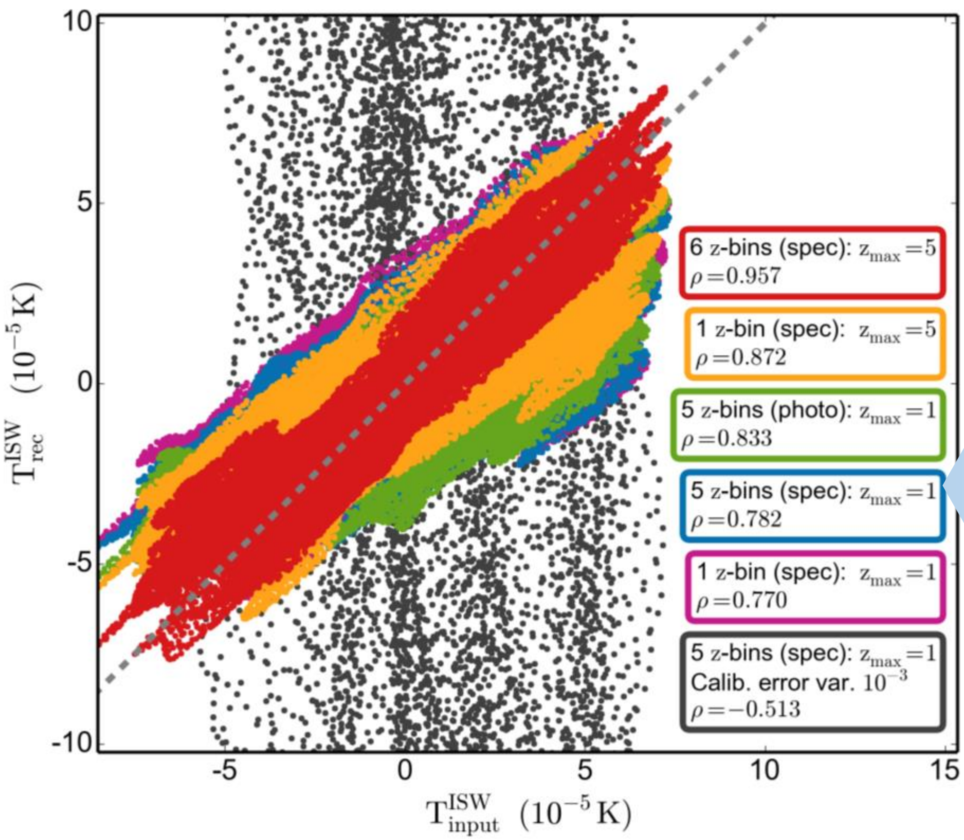
- contamination by noise effects: straylight

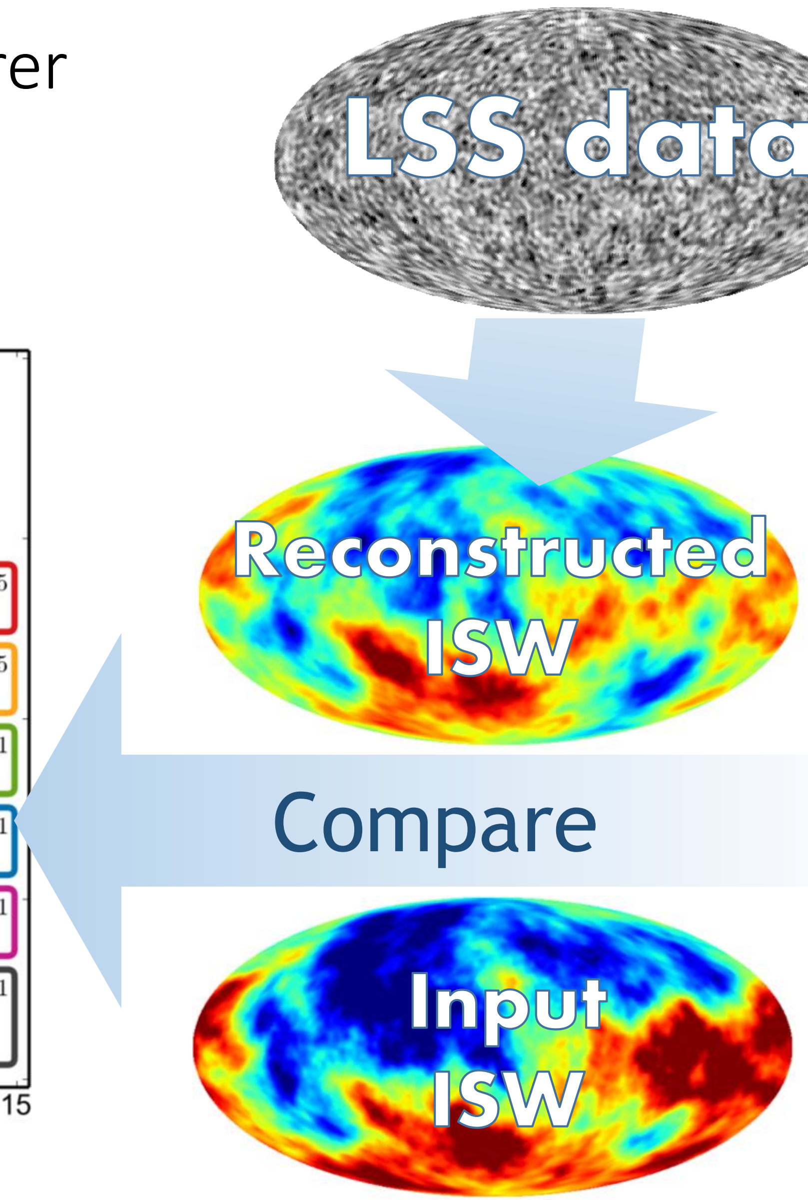
- many pixel-level simulations on 15,000 deg^2 not feasible
- construct fast probabilistic simulations using Mangle ➔ see poster!

- *with Sylvain de la Torre & Julien Zoubian, Marseille, FR (plots courtesy of JZ)*

The impact of LSS survey systematics on ISW signal reconstruction

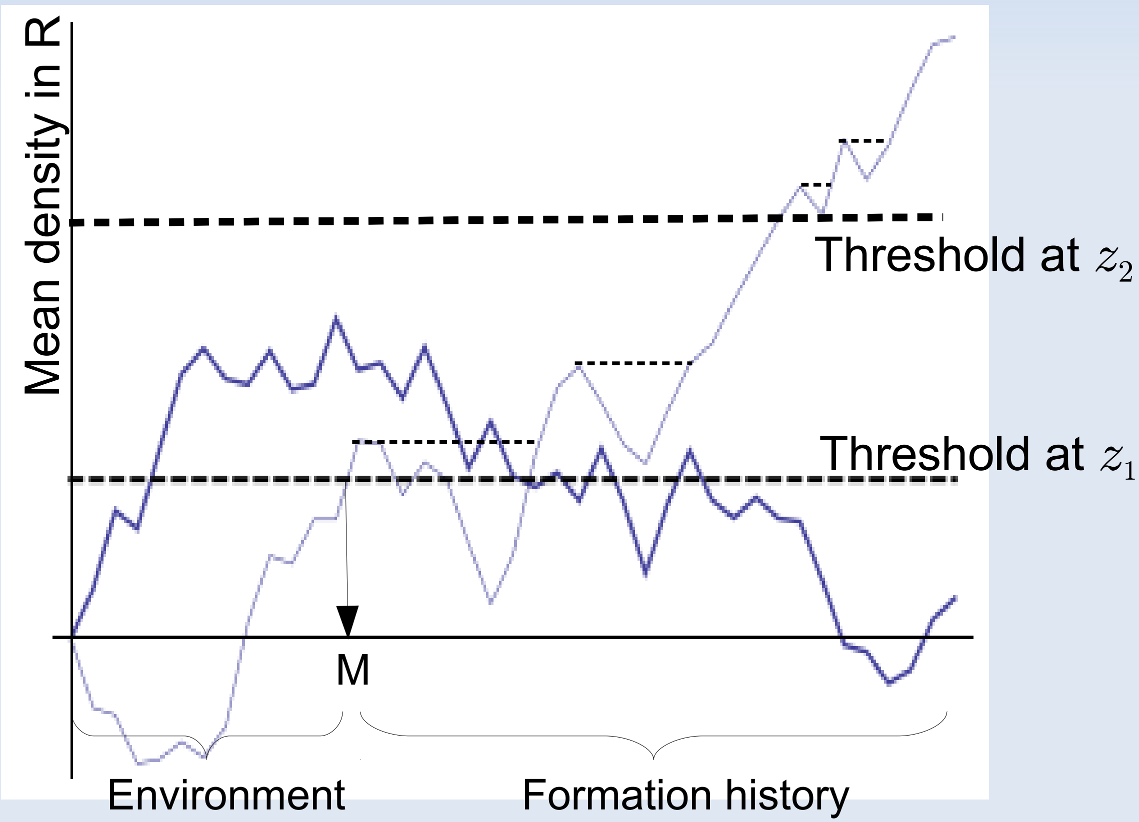
Jessica Muir and Dragan Huterer
University of Michigan

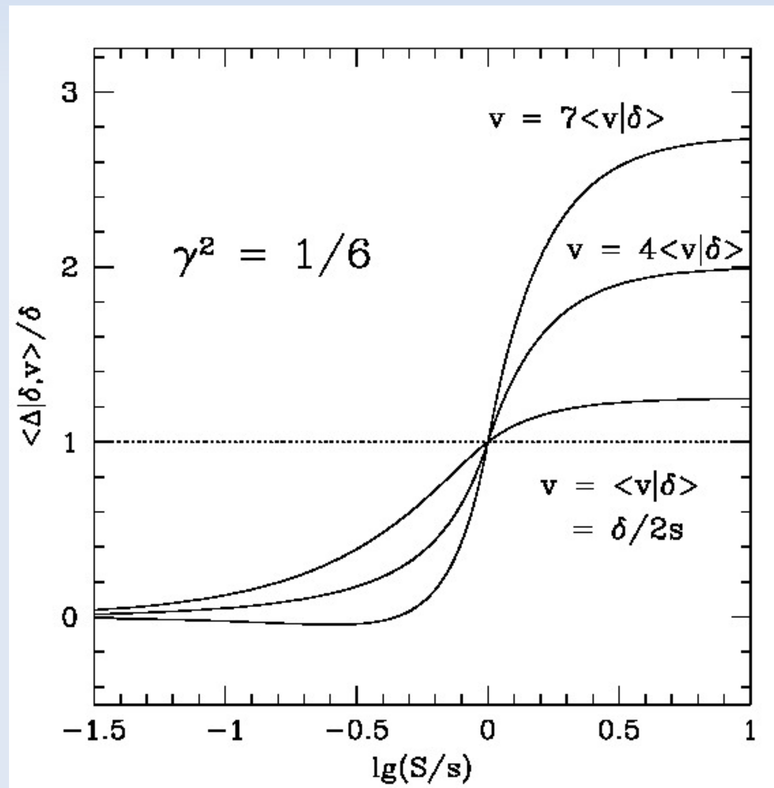




Lagrangian assembly bias

- Small-scale clustering correlates with more than just large-scale mean density
- Formation history correlates with environment
- At same mass, **more concentrated** halos prefer **lower density** environment
- Well described by just one extra variable: **steepness** of Lagrangian profile

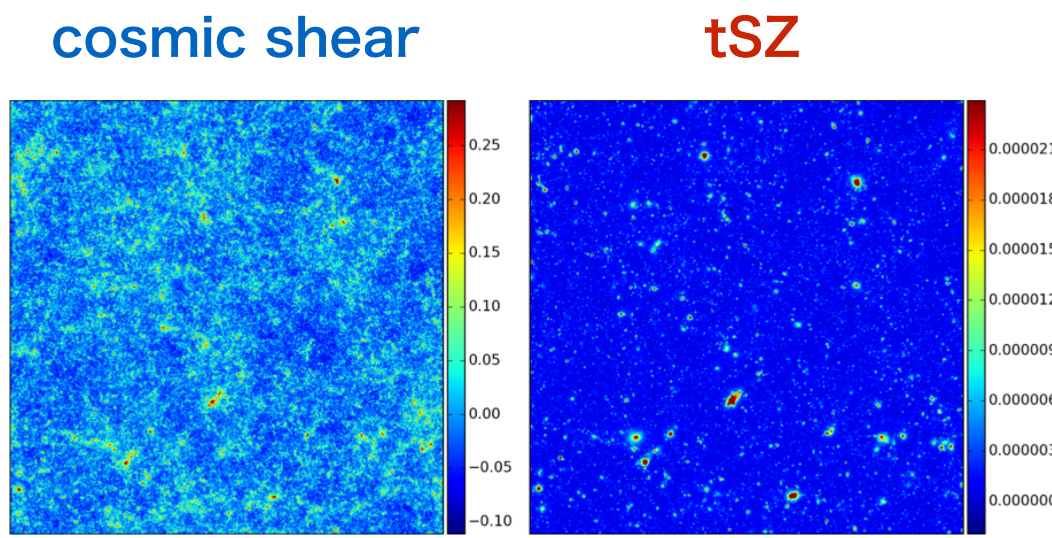




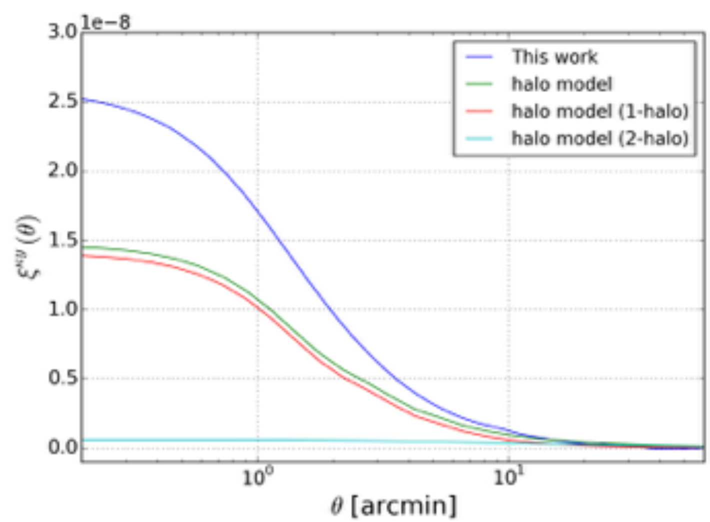
Marcello Musso UPenn & MPA (w/ Ravi Sheth)

Investigating the sigma8 tension by the cross-correlation of tSZ and cosmic shear

Ken Osato (Dept. of Physics, The Univ. of Tokyo)



- ✓ **Cosmic shear and thermal Sunyaev-Zel'dovich effect**
  From our **baryonic N-body simulations**, mock cosmic shear and tSZ maps can be created.
- ✓ **Cross-correlation**
  Angular cross-correlation can be measured from two maps.
  This can be useful in evaluating cosmological parameters like sigma8.

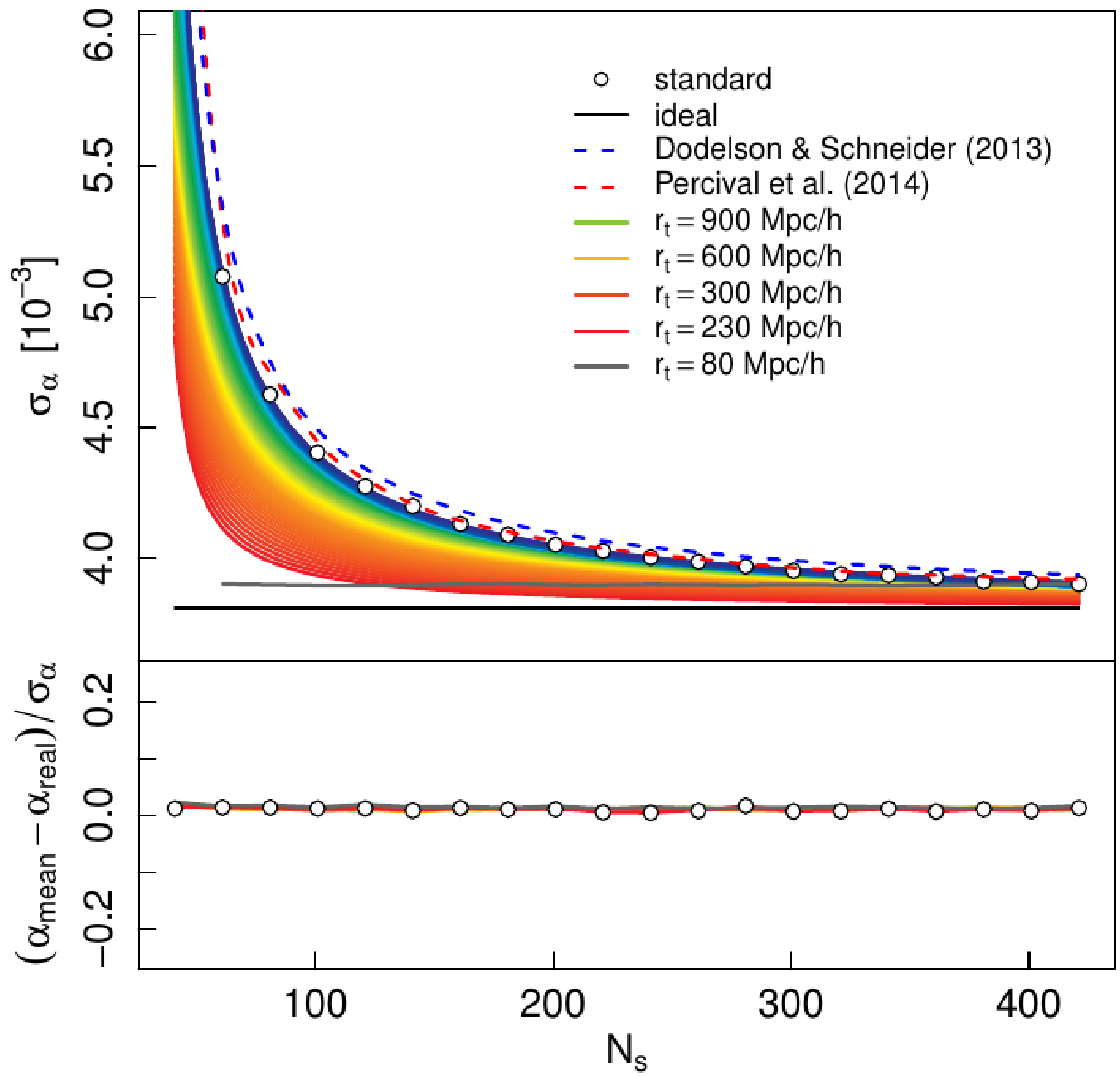


Improving the precision (matrix) in **precision cosmology**

By "tapering" the covariance matrix (**C**) at large scales we get unbiased and less noisy estimation of the precision matrix (**Ψ**):

$$\mathbf{C}_{\rm t} \equiv \hat{\mathbf{C}} \circ \mathbf{T}$$

$$\mathbf{\Psi}^{\rm t} = \mathbf{C}_{\rm t}^{-1} \circ \mathbf{T}$$



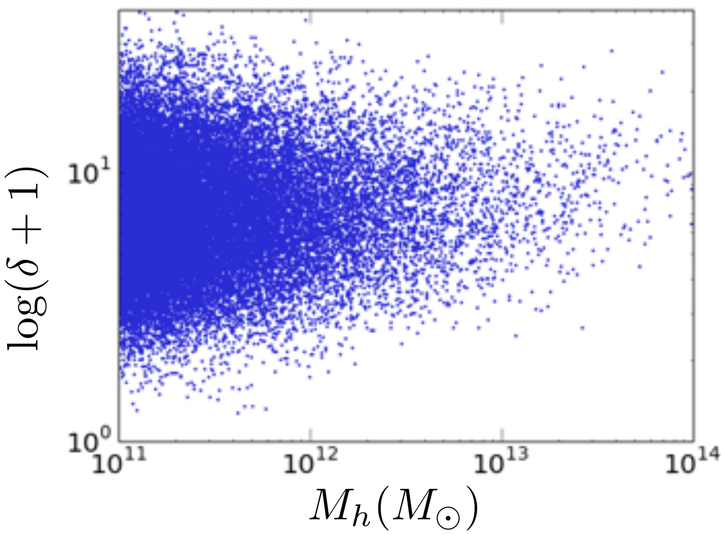
Error of the BAO peak scale (**α**) as function of the number of mocks used to compute **Ψ**. Using tapering method we obtain errors closer to the ideal expectations.

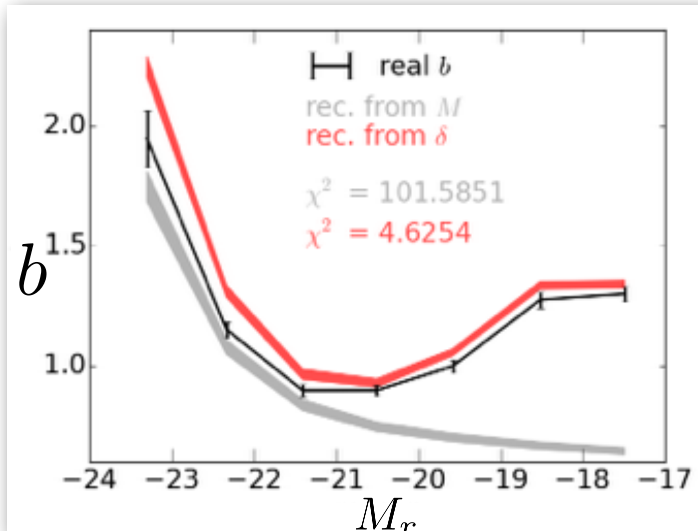
Ariel G. Sanchez (MPE, Germany), Dante J. Paz (IATE, Argentina)

Halo Clustering: Environment vs Mass

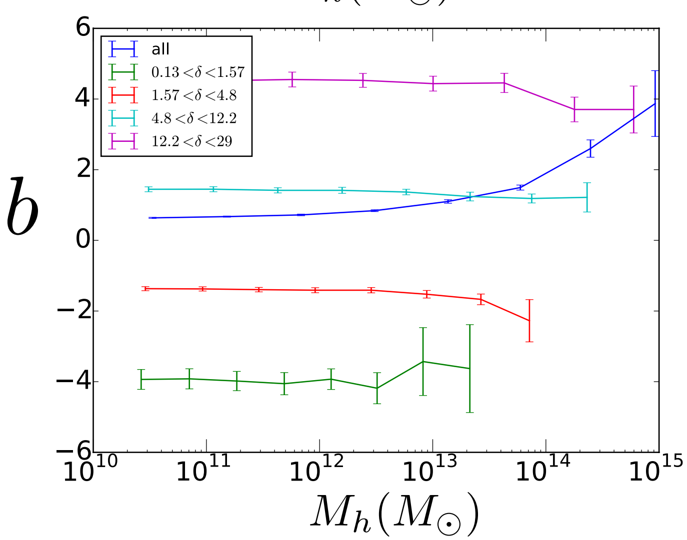
Arnau Pujol
Enrique Gaztañaga

Institut de Ciències de l'Espai (IEEC-CSIC), Barcelona





HOD predictions can be affected by assembly bias. In this case, density (red) predicts much better clustering than mass (grey)



For fixed environmental density, Halo bias does not depend on Mass

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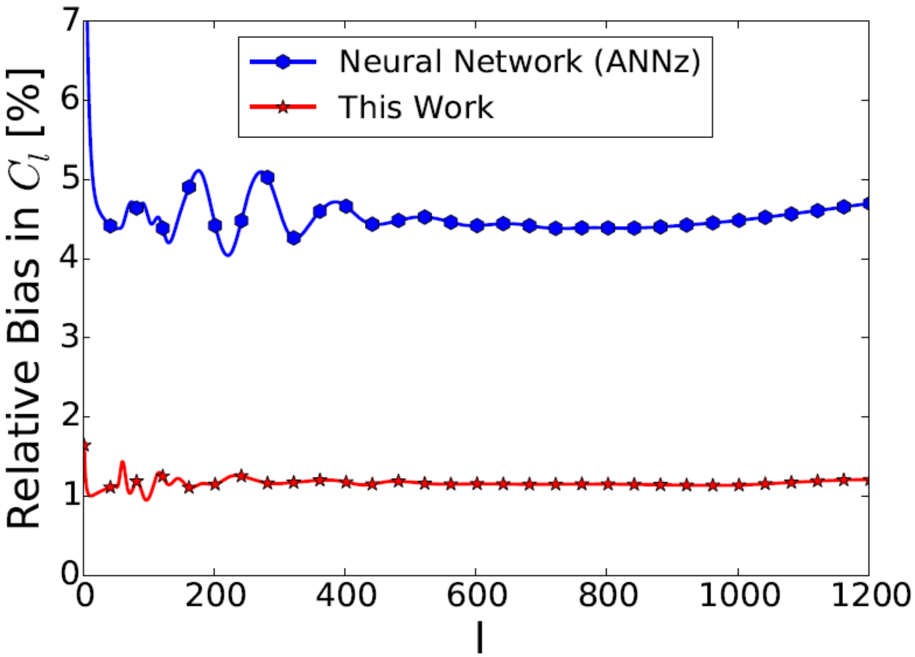
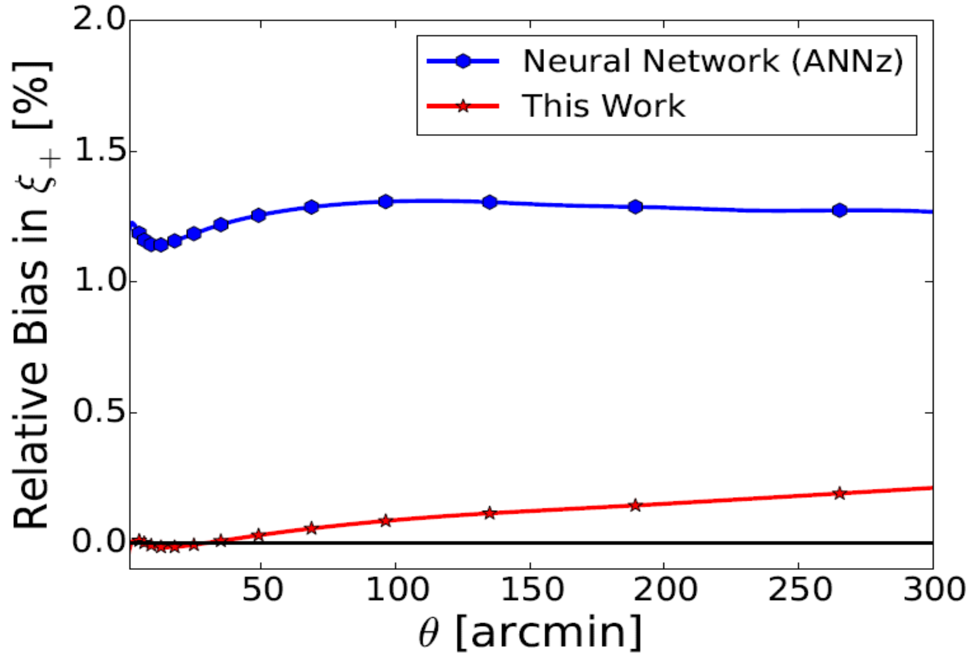
ICE

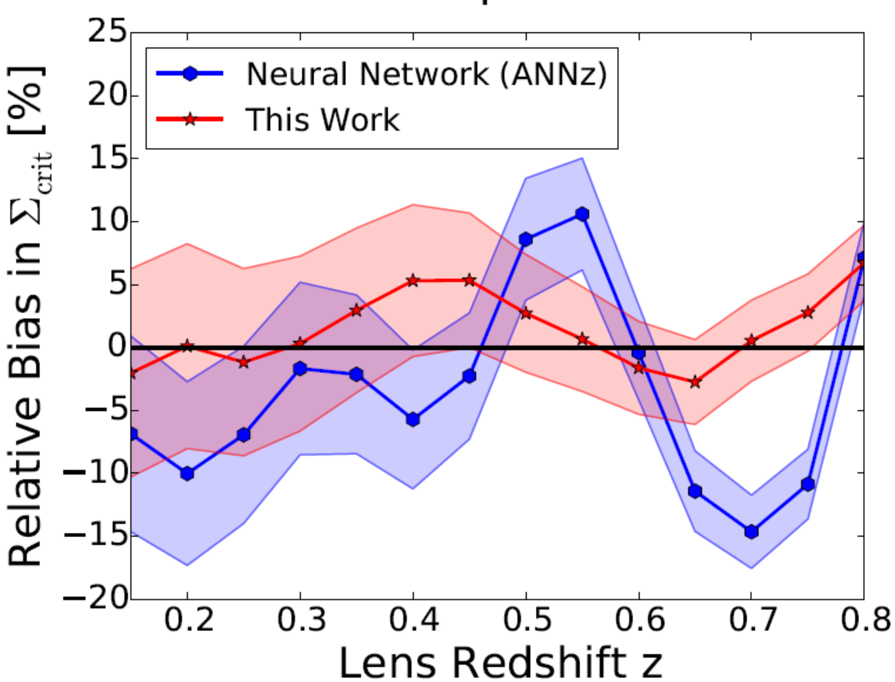
Accurate photometric redshift probability density estimation - method comparison and application

Markus Michael Rau, Stella Seitz, Fabrice Brimioulle, Eibe Frank, Oliver Friedrich, Daniel Gruen, Ben Hoyle

Accepted for publication in the MNRAS 2015 July 10







Low PhotoZ Bias in Weak Lensing and LSS

Markus Michael Rau et al.
Supv. Stella Seitz
arXiv:1503.08215

GALAXY-GALAXY LENSING OBSERVABLES AND COSMOLOGICAL RESCALING

Malin Renneby§, Excellence Cluster Universe, Ludwig-Maximilians-Universität (LMU)
(together with Stefan Hilbert, Excellence Cluster Universe, LMU, and Raul Angulo, Centro de Estudios de Física del Cosmos de Aragón)

Goal: Acquire an accurate, fast and flexible framework to predict large-scale structure observables in order to constrain cosmological parameters as well as galaxy formation models.

Initial step: ΛCDM-setup using the rescaling method detailed in Angulo & White (2010):

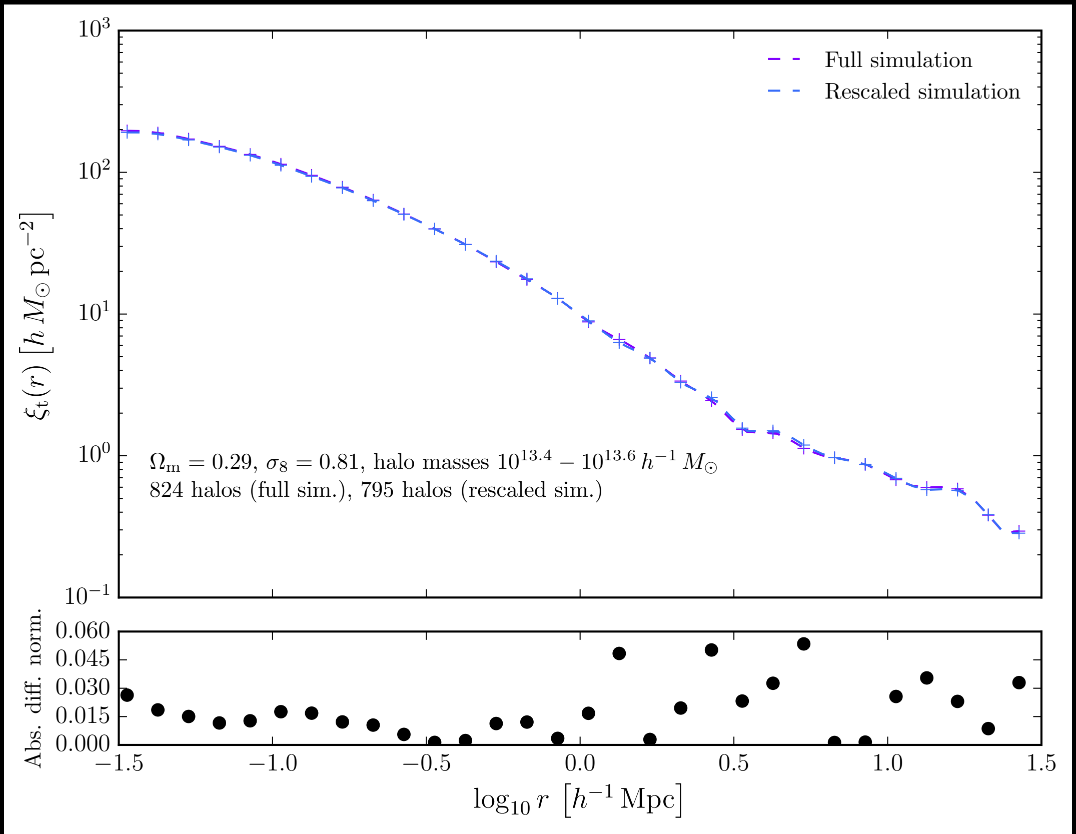
$$m_{\rm p} \to m'_{\rm p} = \left(\frac{\Omega'_{\rm m}}{\Omega_{\rm m}}\right)\left(\frac{H'}{H}\right)^2\left(\frac{L'}{L}\right)^3 m_{\rm p}$$

$$L \to L' = \alpha L$$

"Base cosmology": Small Millennium-simulation: 250 $(h^{-1}\,\mathrm{Mpc})^3$, 5 h^{-1} kpc res., $1080^3 \approx 1.26$ billion DM particles à $8.861\times 10^8\, h^{-1} M_\odot$, $\Omega_m = 0.25$, $\Omega_b = 0.045$, $\Omega_\Lambda = 0.75$, $h = 0.73$, $\sigma_8 = 0.9$.

Target test cosmologies: ($\Omega_m = 0.15$, $\sigma_8 = 1.0$), ($\Omega_m = 0.25$, $\sigma_8 = 0.6$), ($\Omega_m = 0.29$, $\sigma_8 = 0.81$), ($\Omega_m = 0.40$, $\sigma_8 = 0.7$), ($\Omega_m = 0.80$, $\sigma_8 = 0.4$).

Probes: Projected convergence and tangential shear profiles, halo mass function at z = 0.

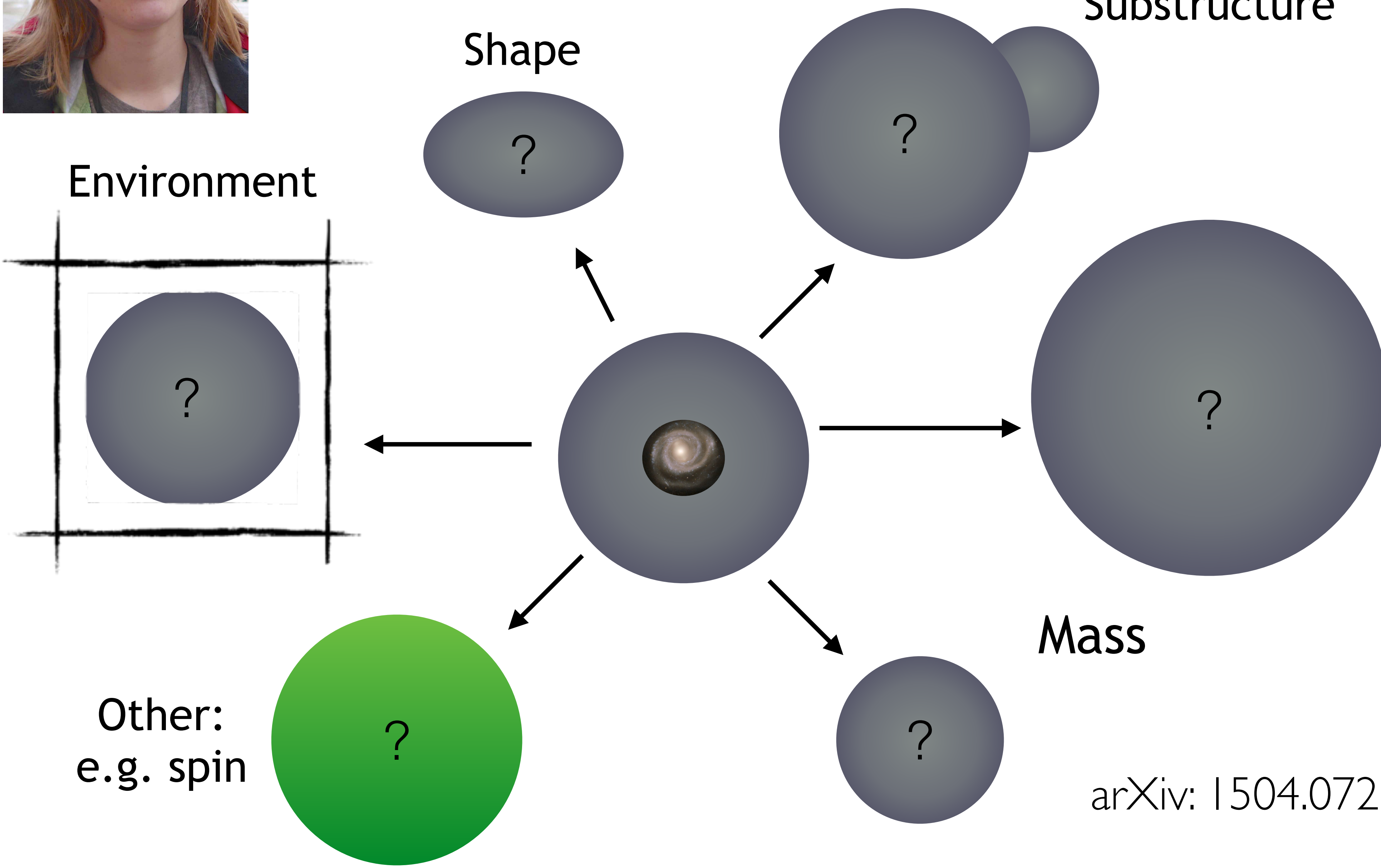


Results: Percentage to sub-percentage deviations for the rescaled simulations with respect to the full simulations for the halo mass function except for the high mass tail, disagreements of the order of a few percent for $\Sigma(r)$ and $\xi_t(r)$ given certain halo masses and radial bin ranges (to appear in Renneby et. al. in prep.).

§malin.renneby@physik.uni-muenchen.de

Genetically modified halos

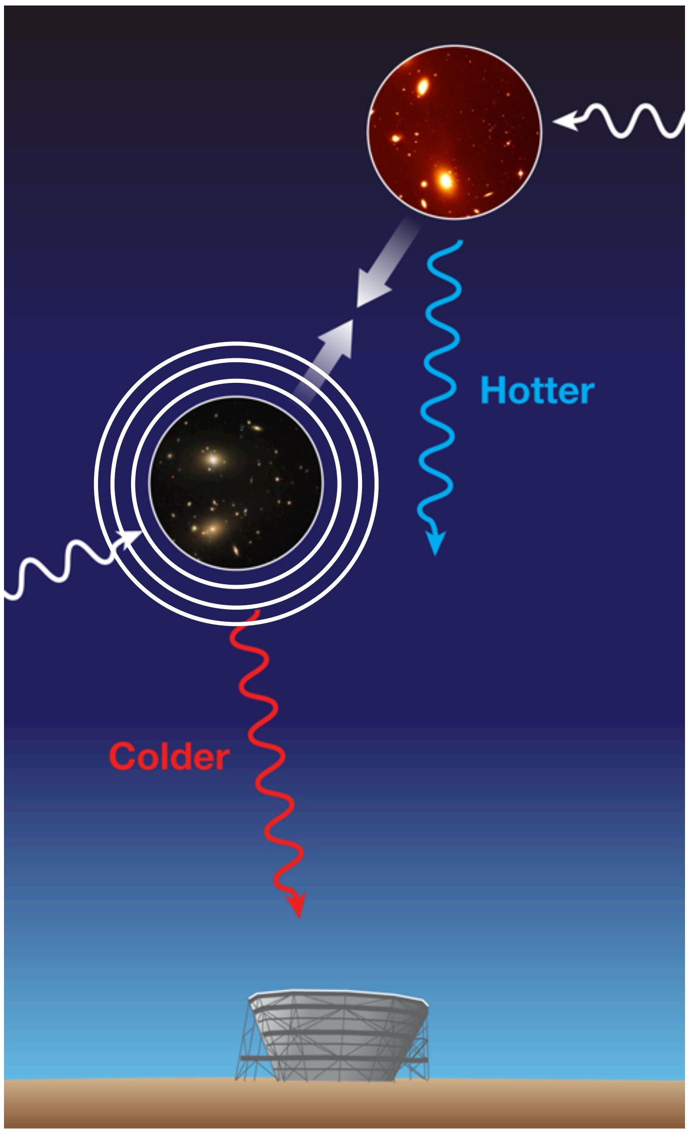
Nina Roth (UCL)

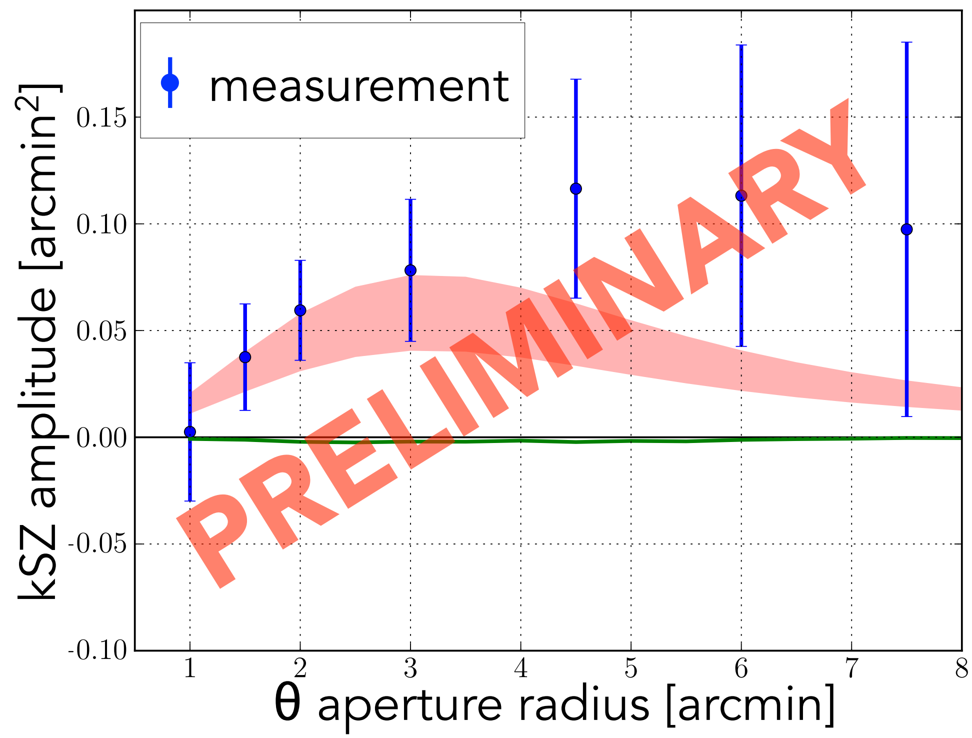


arXiv: 1504.07250

kSZ Effect & Missing Baryons

Emmanuel Schaan, S. Ferraro, M. Vargas-Magaña, K. Smith, S. Ho & ACTPol





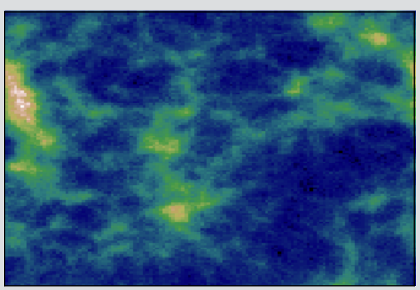
significant detection, implications for baryons and cosmology

Simulations of H I Intensity Maps

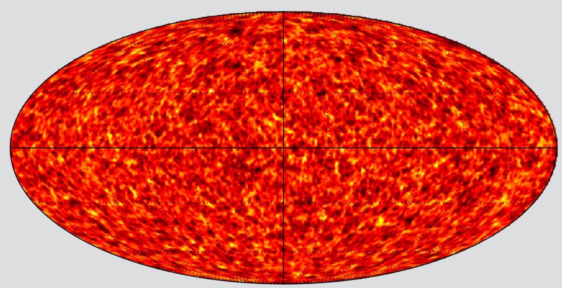
S. Seehars[1], A. Paranjape[1,2], A. Witzemann[1], A. Refregier[1], A. Amara[1], R. Wechsler[3], and M. R. Becker[3]

[1]ETH Zurich, [2]Inter-University Centre for Astronomy and Astrophysics, [3]Stanford University

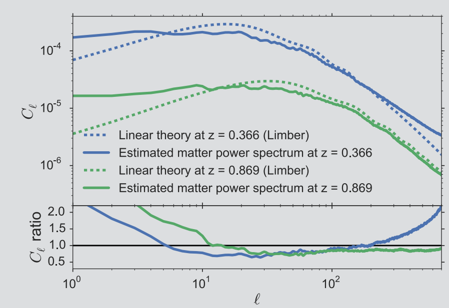
Dark Matter



Intensity Maps



Angular Clustering



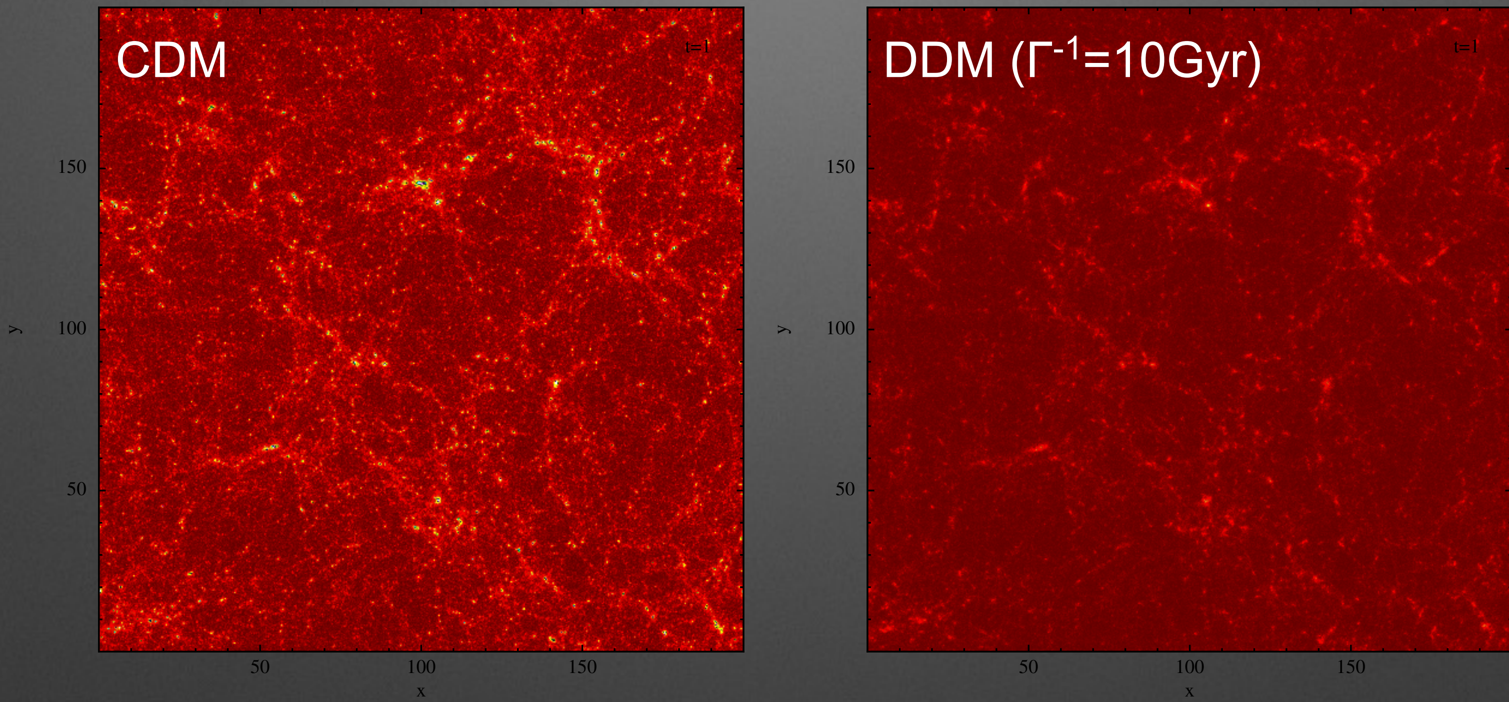
ETH zürich

Munich, July 21st 2015

Structure formation in decaying dark matter model

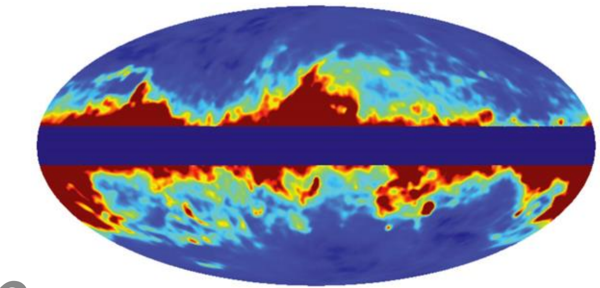
Toyokazu Sekiguchi (Helsinki)

arXiv:1505.05511 with Kari Enqvist, Seshadri Nadathur & Tomo Takahashi



- ✓ N-body simulation in decaying DM model with $\Gamma^{-1} \sim O(1)\ t_{age}$
- ✓ Suppressed matter power spectrum & halo mass function
- ✓ Solution for tensions between Planck ΛCDM and recent observations of LSS including WL, cluster abundance

Multiplicative Errors in the Galaxy Power Spectrum



MNRAS 447, 2961 (2015)
arXiv:1410.0035

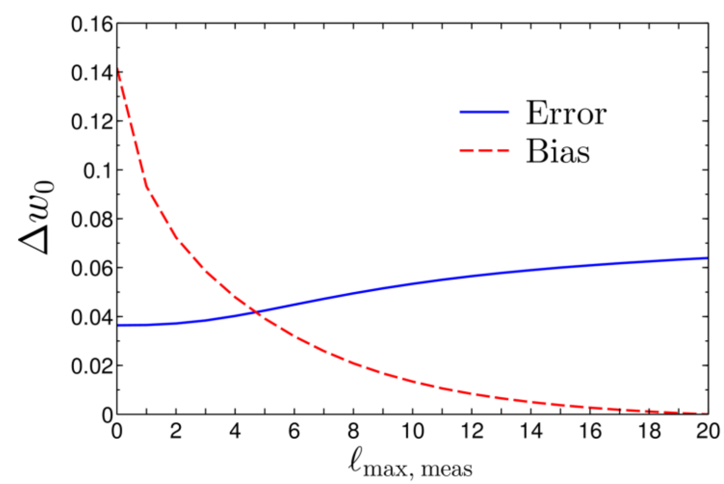
(In collaboration with Dragan Huterer)

Daniel Shafer
University of Michigan

- Large-angle photometric calibration error must be removed from the galaxy power spectrum in order to probe the underlying cosmology.
- There is also a multiplicative effect, where large-angle error propagates to small scales:

$$T_\ell \simeq C_\ell + C_\ell^{\rm cal} - \frac{1}{2\pi} C_\ell^{\rm cal} C_\ell + \sigma_c^2\, C_\ell$$

- We show that multiplicative errors are potentially dangerous for modern surveys, but they can be mitigated by using the large-angle power to measure the contamination directly.



2015.07.20 ~ 2015.07.24
@ESO, Munich

Observational Evidence of the Bridge Effect of Void Filaments

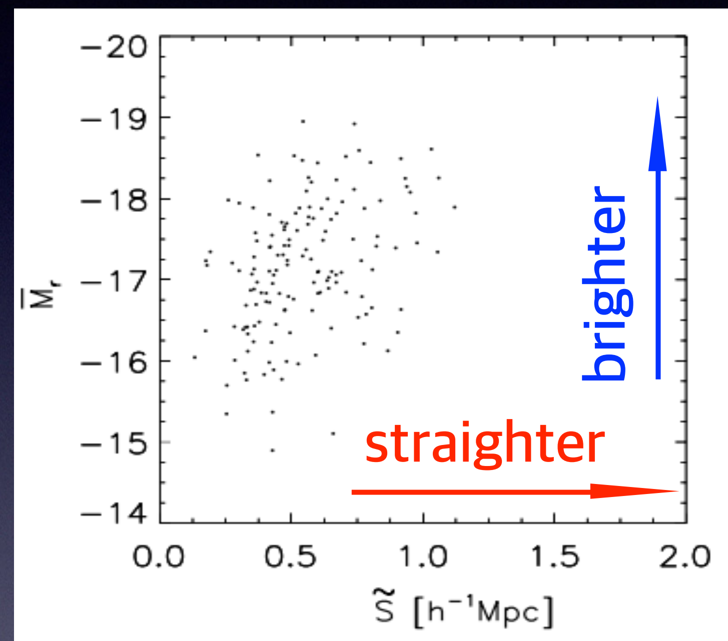
Junsup Shim, Jounghun Lee and Fiona Hoyle

The *bridge effect of void filaments* represents that straighter void filament, as a bridge, transports more efficiently the matter & gas from outer region into void galaxies. (Park & Lee 2009)

In this study, we aim to observationally confirm the *bridge effect of void filaments* using the void catalogue constructed by Pan et al. (2012) from SDSS DR 7.

We found that, on average, the void galaxies are brighter in the straighter host void filament.

It is also found that richer void filaments develop stronger correlation between the luminosity and straightness of the void filament.



(submitted to ApJ)

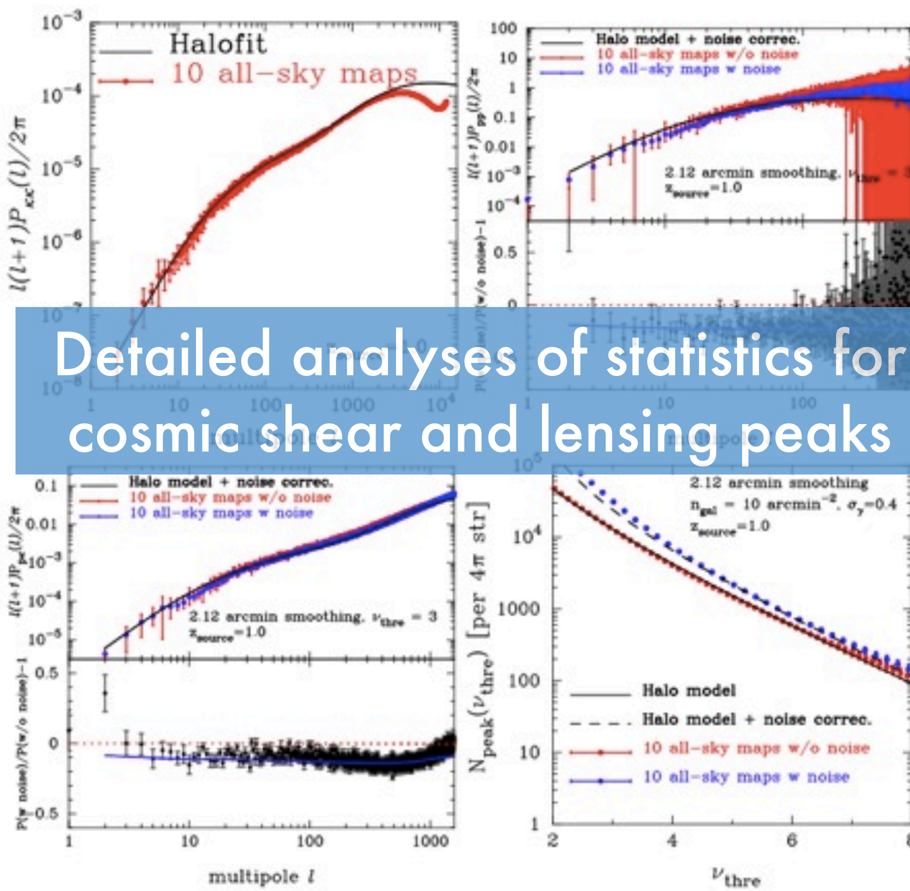
	$4 \leq N_{node} < 7$	$7 \leq N_{node} < 11$	$N_{node} \geq 11$
r	0.29 ± 0.10	0.50 ± 0.13	0.60 ± 0.13
$\bar{z}$	0.012 ± 0.005	0.014 ± 0.003	0.013 ± 0.004

→ richer

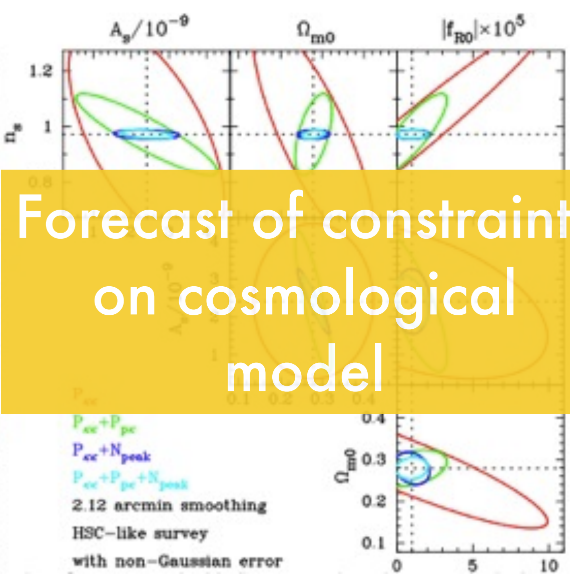
Probing Cosmology with Weak Lensing Selected Clusters
Masato Shirasaki (NAOJ)

Full Sky Ray-tracing Simulation

Weak lensing selected cluster
= **peak** on WL mass map

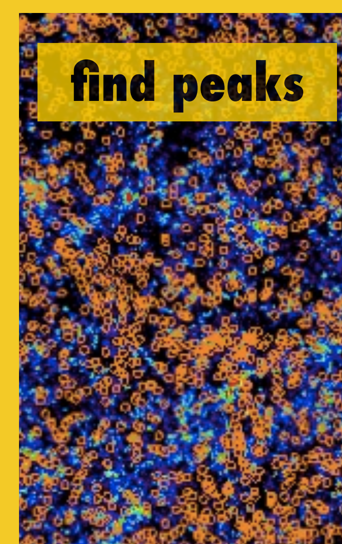


Detailed analyses of statistics for cosmic shear and lensing peaks



Forecast of constraints on cosmological model

WL mass map

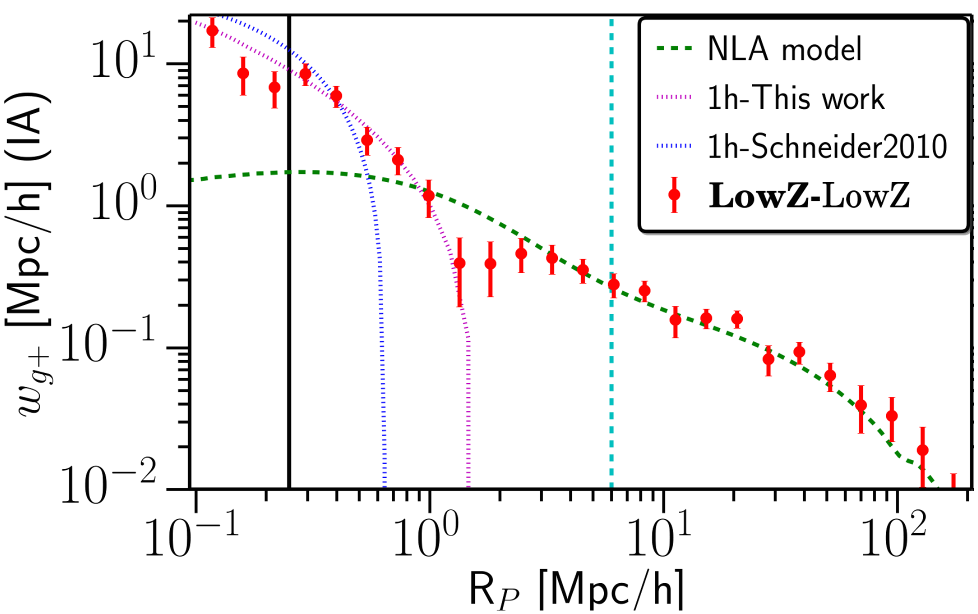


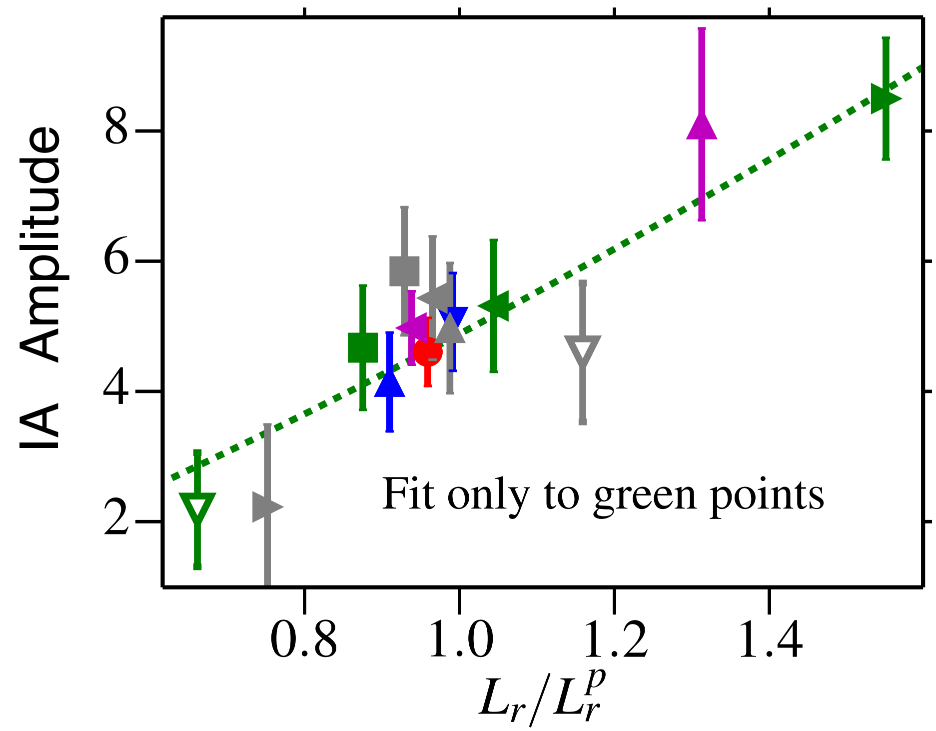
find peaks

Intrinsic Alignments of Galaxies

Sukhdeep Singh[1]*, Rachel Mandelbaum[1]

[1]McWilliams Center for Cosmology, Carnegie Mellon University

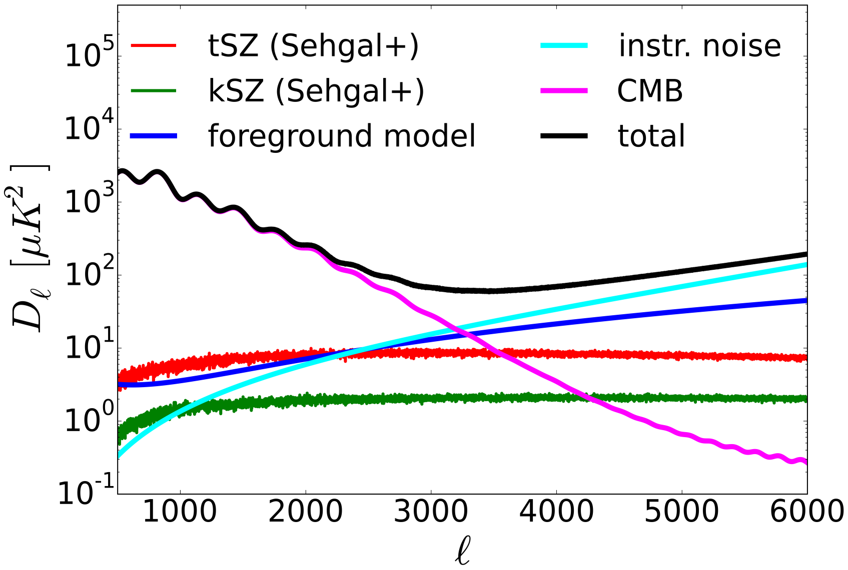


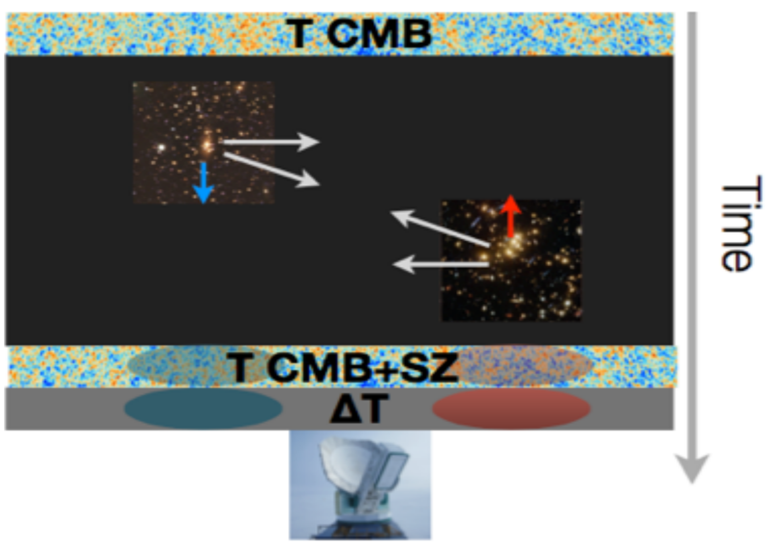


- Intrinsic Alignments (IA) are contaminants in weak lensing studies.
- IA detected at high S/N in SDSS LOWZ galaxies. (**arxiv: 1411.1755**)
- **Luminosity Dependence**: Brighter Galaxies have stronger IA
- **Environment Dependence**: Galaxies in more massive Halos show stronger alignments.

***sukhdeep@cmu.edu**

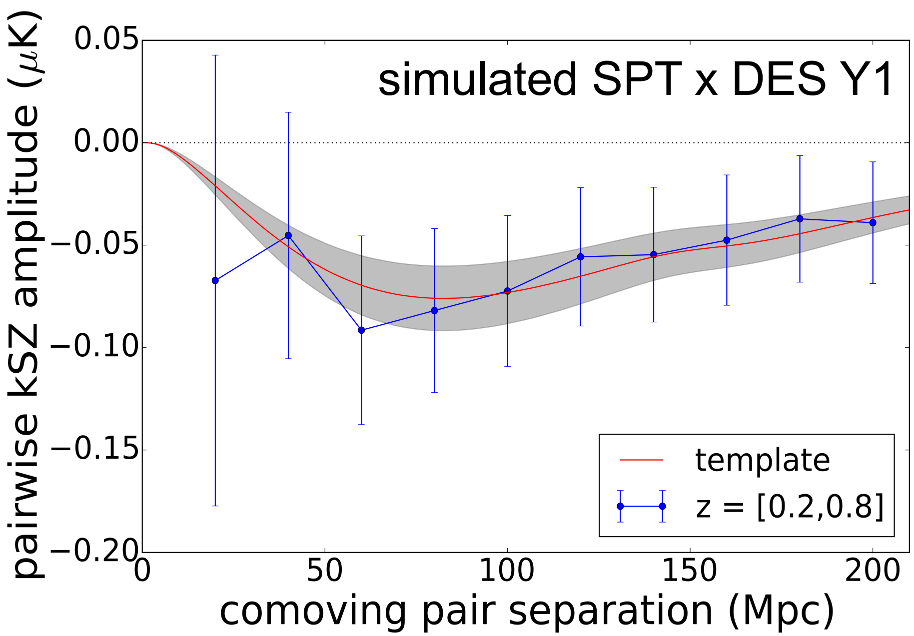
Kinematic SZ from DES clusters & high-res. CMB data





Analytic template vs. simulations (Sehgal+):

- >10σ with SPT x spec.-z cluster sample
- ~ 5σ with SPT x DES Y1 (incl. photo-z errs.)



With real data:

- Testing on DESxACT: indication of a signal (1.7σ)
- now DESxSPT joint analysis, results soon (SPT contacts: K. Story, S. Flender)

B. Soergel, T. Giannantonio, G. Efstathiou + the DES & SPT collaborations

THE DARK ENERGY SURVEY

Leibniz-Institut für Astrophysik Potsdam

Unterstützt von / Supported by
Alexander von Humboldt Stiftung / Foundation

Cosmicflows observations give us CLUES to matter distribution

Jenny Sorce

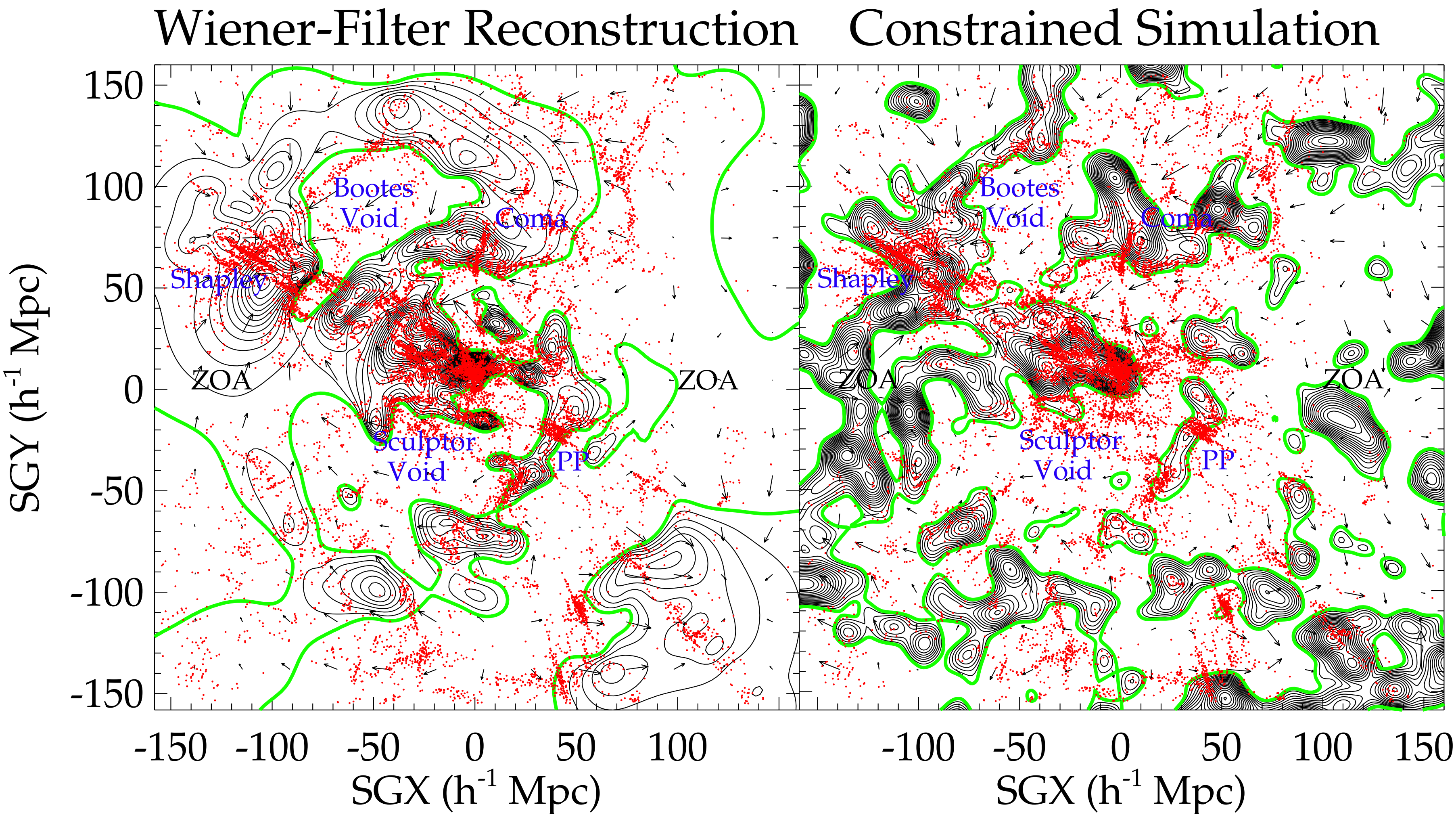
Theoretical and Observational Progress on Large-scale Structure of the Universe
MPA/ESO/MPE/Excellence Cluster Universe Joint Conference 2015

Garching, July 20 th, 2015

AIP / Leibniz-Institut für Astrophysik Potsdam

Observed, Reconstructed and Simulated

Local Large Scale Structure



Analytical approach
to density-weighted velocity correlation function
of Large-Scape Structure

Naonori Sugiyama

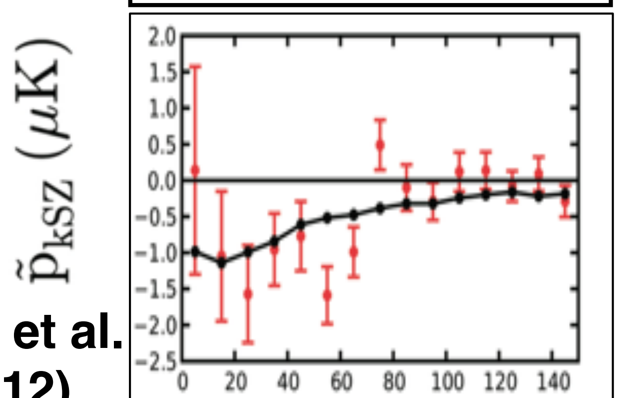
(Collaborators: T.Okumura and D.N.Spergel)

In anticipation of accurate measurement of kSZ effect in the future, an analytical mode of pair-wise velocity correlation function is needed.

Simple relation between pair-wise velocity and density power spectra.

$$\hat{P}_{\rm p}^{(n)}(\vec{k},\hat{n}) = \left(i\frac{aHf}{\vec{k}\cdot\hat{n}}\right)^n \frac{\partial^n}{\partial^n f}\hat{P}_{\rm m}(D,f,\vec{k},\hat{n}).$$

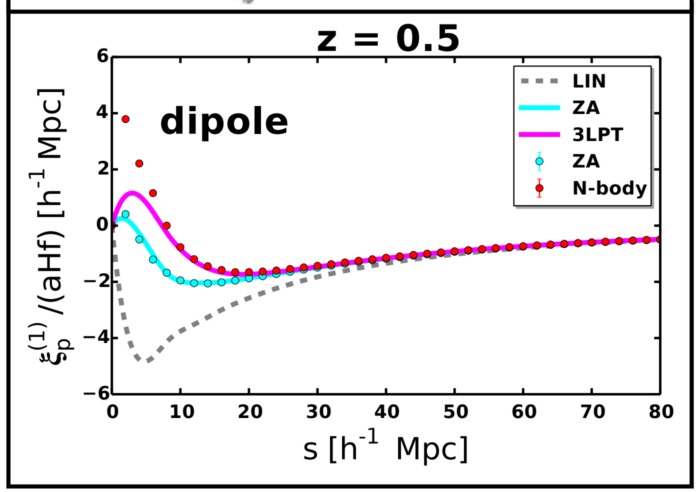
$$\hat{p}_{\rm kSZ}(r) = -\frac{\sum_{i<j}(\delta T_i - \delta T_j)\,c_{i,j}}{\sum_{i<j} c_{i,j}^2}$$



Mpc

Hand et al. (2012)

$$\hat{\xi}_{\rm p}^{(1)}(\vec{s}) = \frac{V}{N_{\rm p}^2}\sum_{i,j}\left[\hat{n}\cdot\vec{v}_i - \hat{n}\cdot\vec{v}_j\right]\left[\delta_{\rm D}(\vec{s}-\vec{s}_{ij}) - \frac{1}{V}\right]$$



The non-linear relativistic universe

Dan B Thomas[1,2], Marco Bruni[1], David Wands[1]

[1]ICG, Portsmouth, UK; [2]University of Cyprus, Nicosia, Cyprus

An introduction to the post-Friedmann approach

The post-Friedmann approach [1] is based on a post-Newtonian type expansion in inverse powers of the speed of light, c, but designed for a ΛCDM FRW cosmology rather than an isolated object such as the solar system. The post-Friedmann formalism is based on a Poisson gauge metric (see below).

The leading order of the expansion is equivalent to taking the weak field, quasi-static, low velocity limit of the Einstein equations. Importantly, in this limit, the density contrast is not required to be small. Equivalently, this limit can be thought of as keeping the potentials small, but allowing their derivatives to be large.

The advantage of the expansion is that it allows equations beyond the exact limiting case to be derived, for example the equation for the vector potential in the metric.

Post-Friedmann metric

$$g_{00} = -\left(1 - \frac{2U_N}{c^2} + \frac{1}{c^4}(2U_N^2 - 4U_P)\right)$$

$$g_{0i} = -a\frac{B_i}{c^3}$$

$$g_{ij} = a^2\left(\left[1 + \frac{2V_N}{c^2} + \frac{2V_N^2 + 4V_P}{c^4}\right]\delta_{ij} + \frac{h_{ij}}{c^4}\right)$$

Leading Order Gravitational Equations

Using the post-Friedmann expansion, we can extract the leading order (c^{-2} and c^{-3}) gravitational equations. In addition to the standard Newton-Poisson equation, we get an equation setting the two scalar potentials to be equal, as expected in a Newtonian regime.

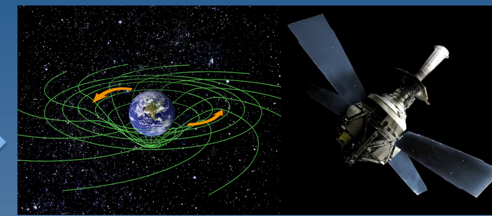
There is also an equation for the vector potential in the metric, which is sourced by the vector part of the momentum field. In the Newtonian limit, i.e. where the approximations hold exactly, this term vanishes, hence the requirement to use an expansion rather than just applying the approximations to the full Einstein equations.

Scalar equations

$$\frac{1}{c^2}\nabla^2 V_N = -\frac{4\pi G a^2 \rho_b}{c^2}\delta; \quad \frac{2}{c^2 a^2}\nabla^2(V_N - U_N) = 0$$

Vector equation

$$\frac{1}{c^3}\nabla^2 B_i = -\frac{16\pi G a^2 \rho_b}{c^3}(1+\delta)v_i + \frac{2}{c^3}\left(\dot{a}U_{N,i} + a\dot{V}_{N,i}\right)$$



Picture credits: Gravity probe B team at Stanford (left) and Katherine Stephenson, Stanford University and Lockheed Martin Corporation (right).

What is the vector potential?

The vector potential in the metric represents the ubiquitous relativistic effect of frame-dragging. A rotating massive body "drags" space-time around itself, causing test particles to spiral around the massive body. Gravity probe B [2] has measured this frame dragging effect for the Earth, finding it to be consistent with the value expected for General Relativity.

Why is Newtonian theory not enough?

Newtonian theory is widely used (typically using N-body simulations) to study non-linear scales in the universe. However,

- We would like to be able to test the approximations built into the Newtonian limit.
- There exist quantities in General Relativity that don't exist in Newtonian gravity, such as gravitational waves, the second scalar potential and the vector gravitational potential.

To completely characterise the universe on non-linear scales, we need to go beyond Newtonian theory

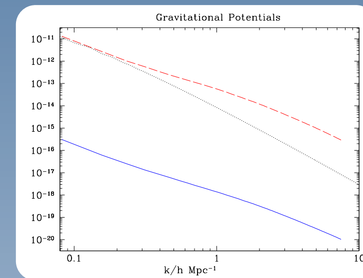
Weak lensing

We have derived the complete weak lensing deflection angle up to c^{-4} order on fully non-linear scales [7]. This deflection angle is shown below, where the blue term on the first line is the standard weak lensing formula.

The blue terms on the third line comprise the Born correction and lens-lens coupling, which are the "first-order squared" terms that are included when ray tracing is performed. The extra terms show the additional relativistic terms that should be included at this order for consistency: the red terms are the contributions from the vector potential, the green term is from the tensor perturbations and the purple term is from the difference in the scalar potentials.

We have performed an order of magnitude estimate of the lensing affects from the vector potential, the lowest order correction to the standard ray tracing. We have shown that its contributions to both the E- and B-modes of cosmic shear are negligible for the next generation of weak-lensing surveys, thus justifying the standard ray-tracing approach.

$$\alpha^i = \int_0^{\chi_s} d\chi \left(\frac{\chi - \chi_s}{\chi_s}\right)\left[\begin{array}{c} \frac{1}{c^2}(U_N + V_N)^{,i} - \frac{1}{c^3}B^{;i}_{\chi} \\ + \frac{2}{c^4}(U_P + V_P)^{,i} - \frac{a}{c^4}\dot{B}^i + \frac{1}{2c^4}h^{;i}_{\chi\chi} \\ + \frac{1}{c^4}(U_N + V_N)^{,i}_{,j}\int_0^{\chi} d\chi'(\chi - \chi')(U_N + V_N)^{,j} \end{array}\right]$$



The power spectra of the scalar (red) and vector (blue) gravitational potentials, as extracted from N-body simulations. The grey curve is the linear theory scalar potential power spectrum for comparison.

Extraction from N-body simulations

In the leading order regime, the velocity and density fields obey the standard Newtonian equations of motion. Thus, by extracting the momentum field from N-body simulations (run using GADGET-2 [3] and analysed using DTFE [4]), the power spectrum of the vector potential can be calculated [5,6].

We found that the power spectrum of the vector potential is of order 10^5 times smaller than the power spectrum of the standard scalar gravitational potential. This small value suggests that

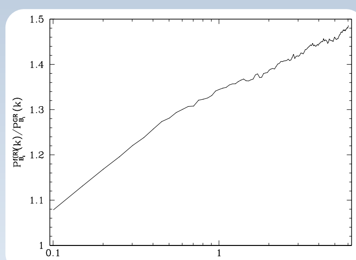
- The approximations inherent to the Newtonian regime are highly accurate
- Future observations (such as weak lensing, see over) are insensitive to the presence of the vector potential, even on non-linear scales

f(R) gravity

(in collaboration with Kazuya Koyama, Baojiu Li and Gong-bo Zhao)

The post-Friedmann formalism can be applied to other metric theories of gravity, not just General Relativity. We have applied it to Hu-Sawicki [8] f(R) gravity and derived the leading order gravitational equations. These include an equation for the vector potential, which we then extracted from f(R) N-body simulations, run using the ECOSMOG code [9].

As for GR, the small magnitude of the vector potential suggests that the approximations used to derive the equations used in the f(R) N-body simulations are valid, and also that future observations are only sensitive to the leading order scalar potentials.



The ratio of the vector power spectra in f(R) gravity and in General Relativity, as extracted from N-body simulations with the same initial conditions.

Conclusions

- We have examined the non-linear universe beyond Newtonian gravity, in particular focussing on the vector potential, which is the first correction to Newtonian gravity.
- We have extracted the vector potential from ΛCDM N-body simulations and found its power spectrum to be of order 10^5 times smaller than that of the scalar potential.
- This small value of the vector potential suggests that the approximations in the Newtonian regime are highly accurate.
- We have calculated the complete weak-lensing deflection angle on non-linear scales and shown that the additional relativistic contributions are small, thus justifying the standard ray-tracing approach.
- We have also examined f(R) gravity, again showing the vector potential to be small. This has similar consequences to the ΛCDM case.

Acknowledgements

We thank Marius Cautun for help with the publicly available DTFE code and Hector Gil Marin for provision of, and help with, a Cloud-in-Cells code. We also thank Marc Manera for useful discussions and technical assistance. Part of the numerical work was done on the Sciama High Performance Computer (HPC) cluster which is supported by the Institute of Cosmology and Gravitation (ICG) and the University of Portsmouth. The remainder was carried out on the COSMOS Shared Memory system at DAMTP, University of Cambridge operated on behalf of the STFC DiRAC HPC Facility. This equipment is funded by BIS National E-infrastructure capital grant ST/J005673/1 and STFC grants ST/H008586/1, ST/K00333X/1. This research was supported by STFC grants ST/H002774/1 and ST/K00090X/1.

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Dusty Starbursts and AGNs in a z=3.1 Protocluster revealed by ALMA

Hideki Umehata (ESO, Univ. of Tokyo)

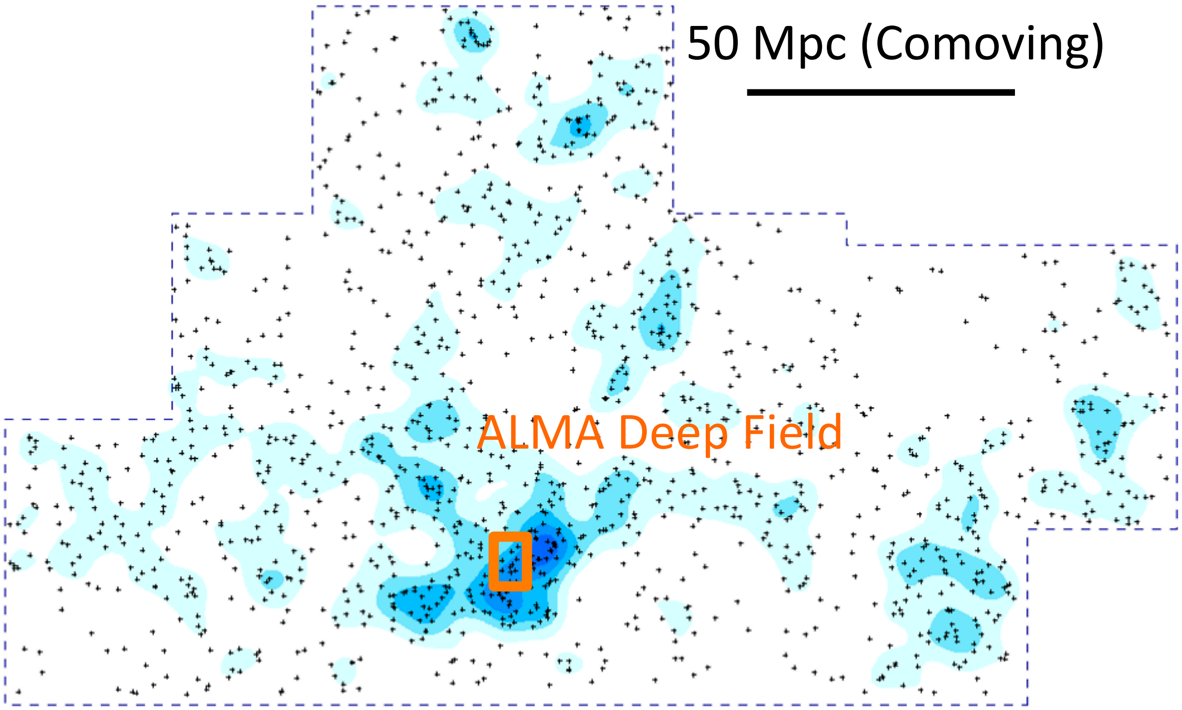
Theme: The most active populations and Cosmic Structure

Observation: ALMA Deep Field at the node of Cosmic Web at z=3.09

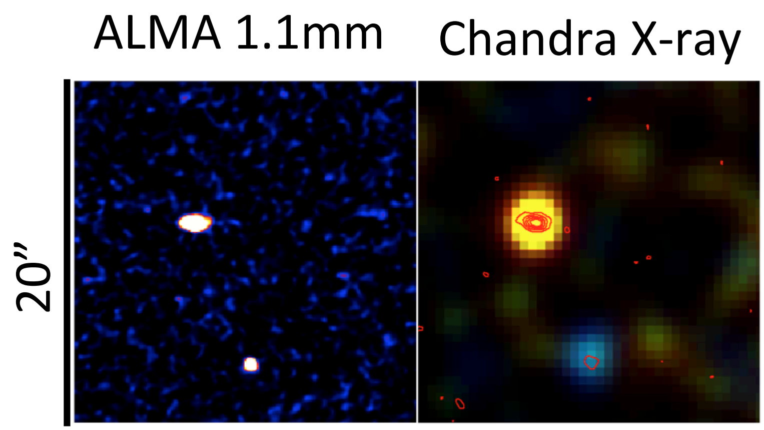
Results:

- Excess of SMGs (30 times)
- A number of multiple SMGs
- High AGN fraction (60%)

=> <u>vigorous star-formation and SMBH growth at the node (~3Mpc scale).</u>

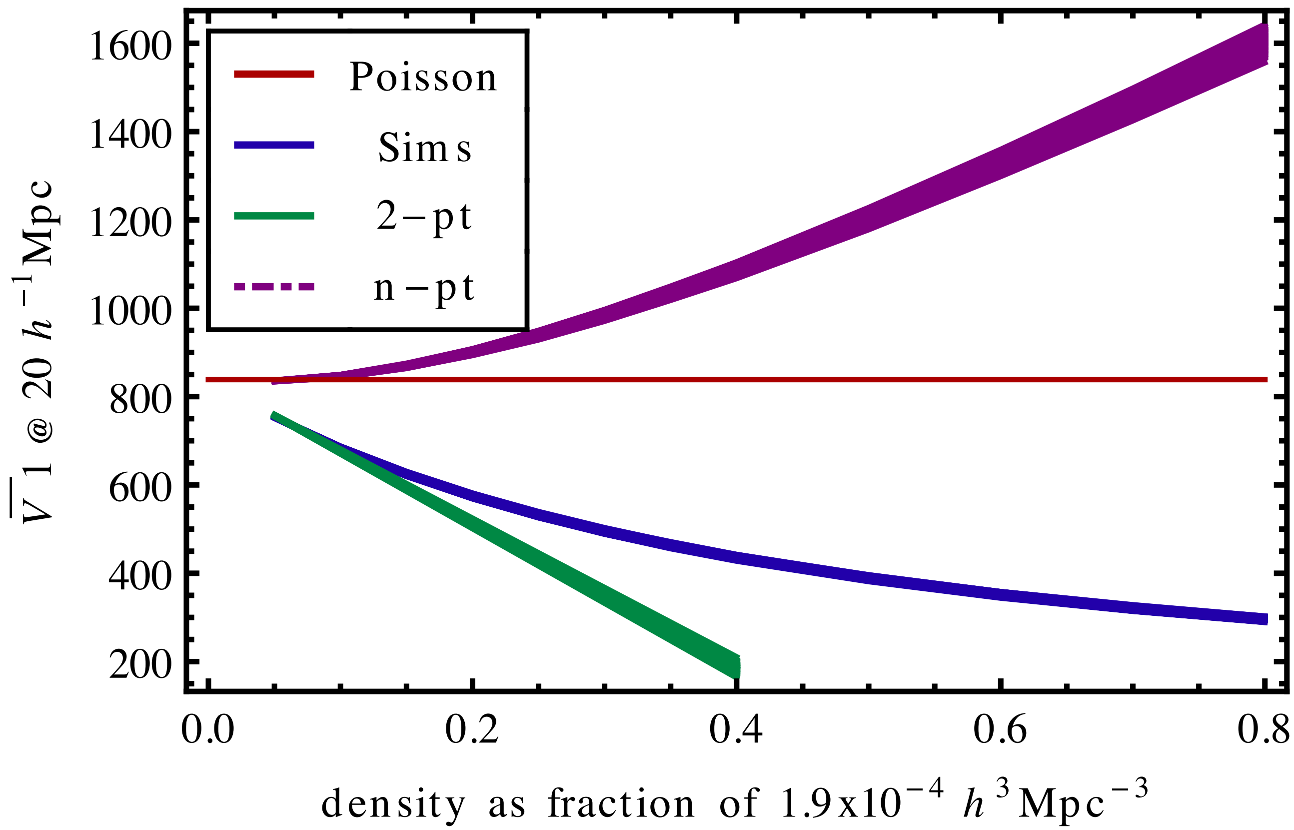


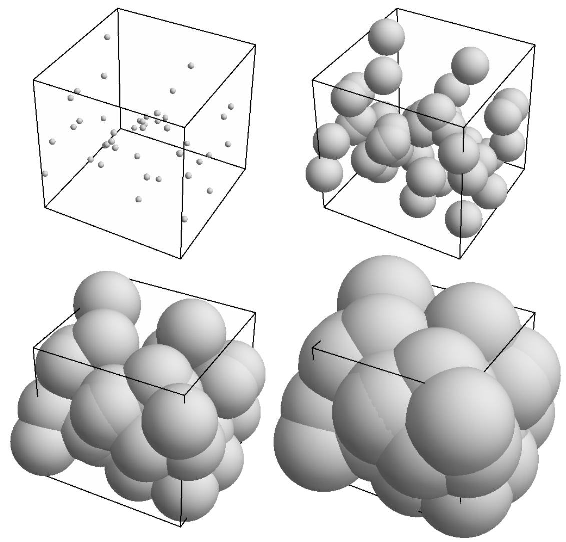
z=3.09 Large Scale Structure traced by LAEs (Yamada+2012)

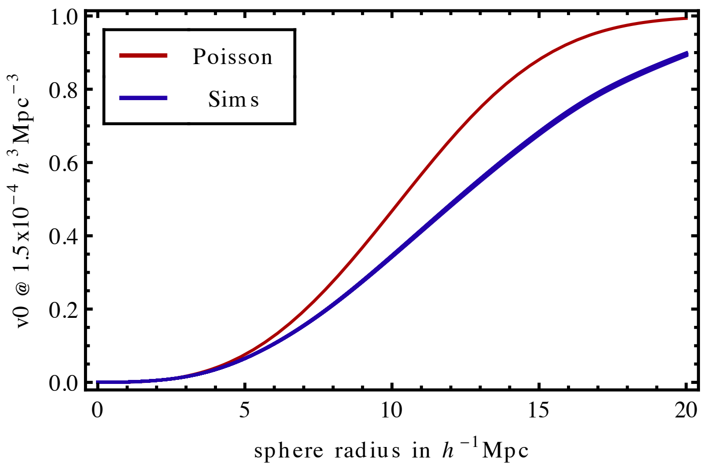


Example of AGN-host SMGs

Minkowski functionals as a tracer of cosmic inhomogeneity







- Full n-point hierarchy ξ_{n+1} probed
- Highly significant detection of non-Gaussian correlations

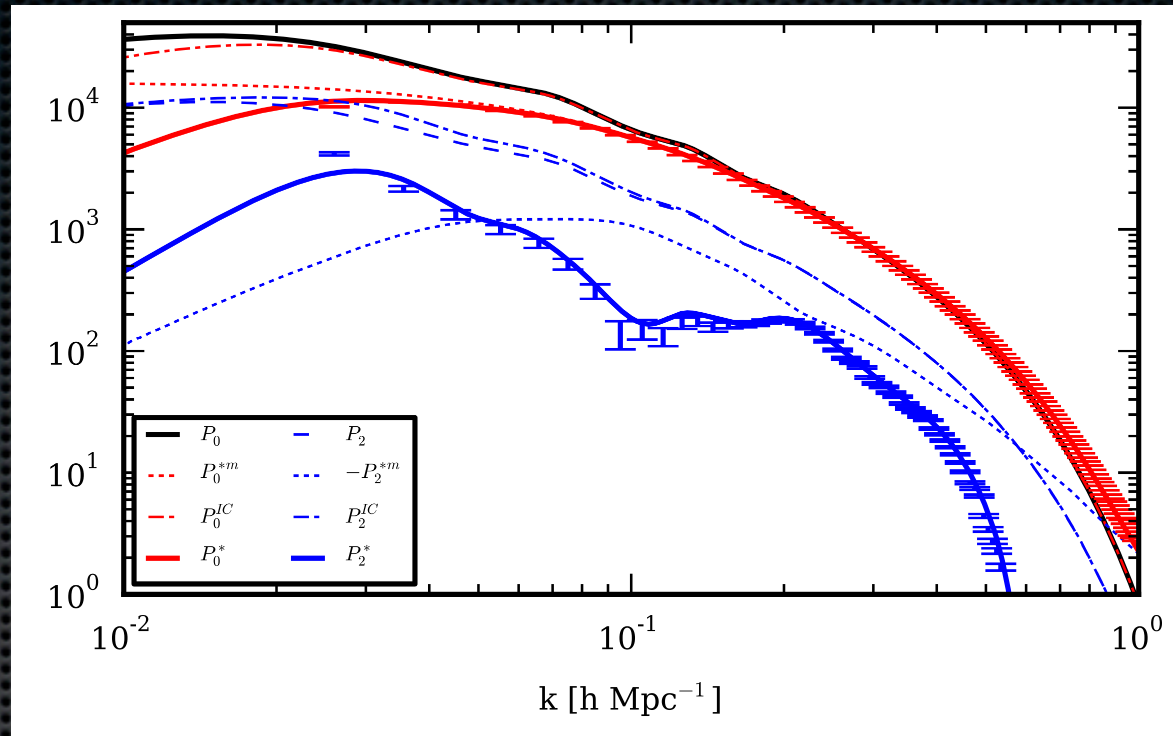
Clipping the wings of non-linear structure

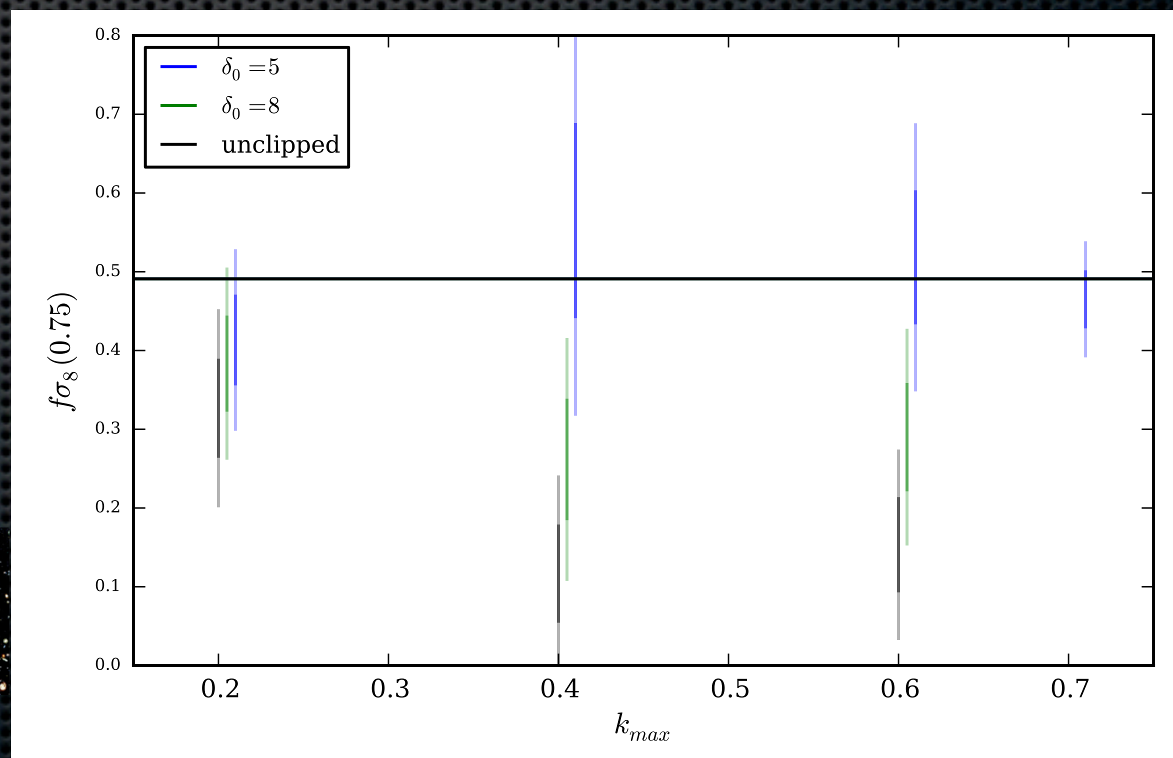
Michael Wilson

Prof. J. Peacock,
Dr S. de la Torre,
Prof. A. Taylor

GAMA

VIPERS
VIMOS PUBLIC EXTRAGALACTIC REDSHIFT SURVEY





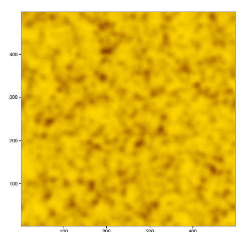
Intensity Mapping Cross-Correlations:

Connecting the Largest Scales to Galaxy Evolution

LAURA WOLZ

University of Melbourne

In Collaboration with Chiara Tonini, Chris Blake and Stuart Wyithe



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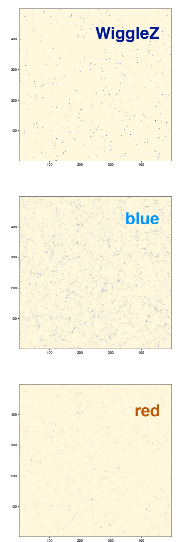

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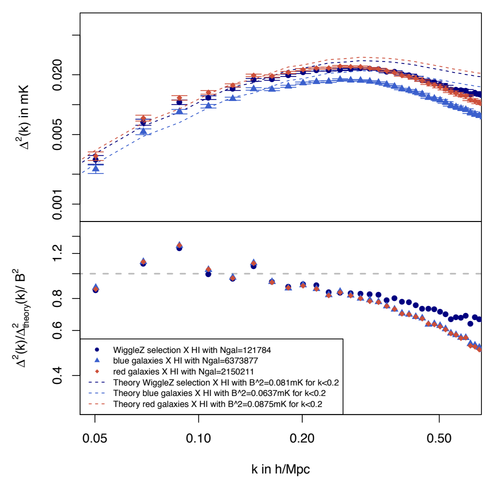

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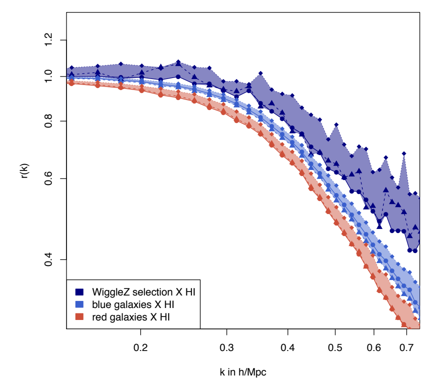
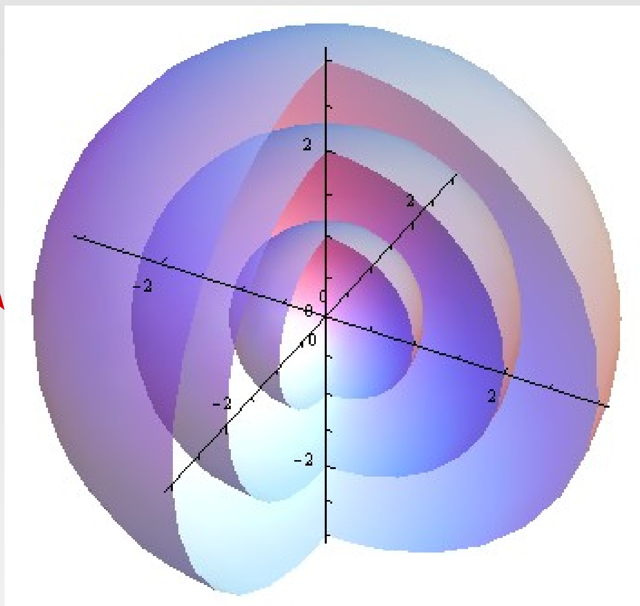


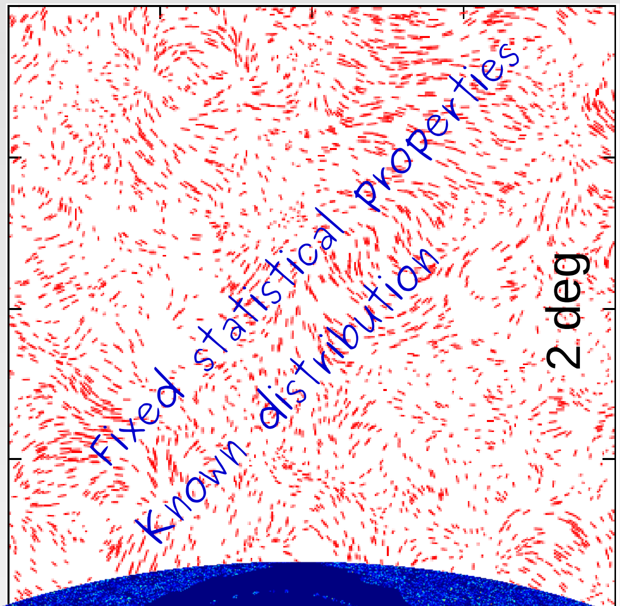
Theoretical and Observational Progress on Large-scale Structure of the Universe, Munich

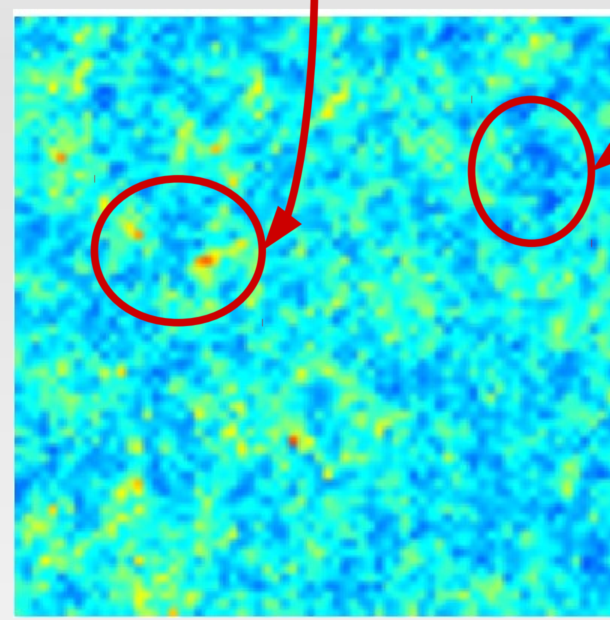
21.07.2015

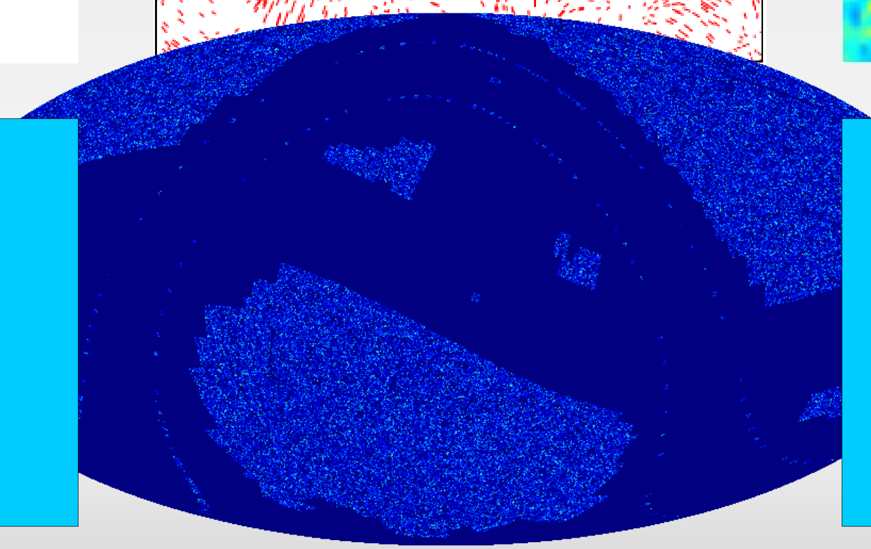
Full-sky realisations of correlated lognormal fields

$$C_l^{\delta\kappa}(z,z')\,\delta_l^{l'}\,\delta_m^{m'} = \langle \delta_{lm}(z)\,\kappa^{*}_{l'm'}(z')\rangle$$









Spherical symmetry

Redshift Space Distortions
Evolution
Selection effects
Wide area surveys

Applications

Cov. Matrix estimation
Tests for systematics
Estimator validation

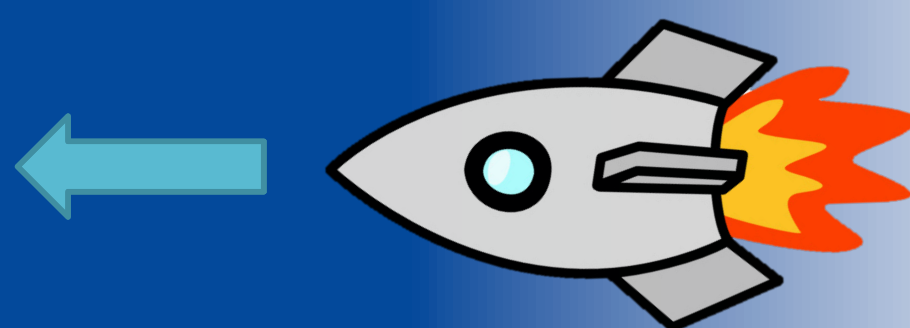
Henrique
S. Xavier

Kinematic Dipole Detection with Galaxy Surveys

Mijin Yoon

Dragan Huterer

University of Michigan

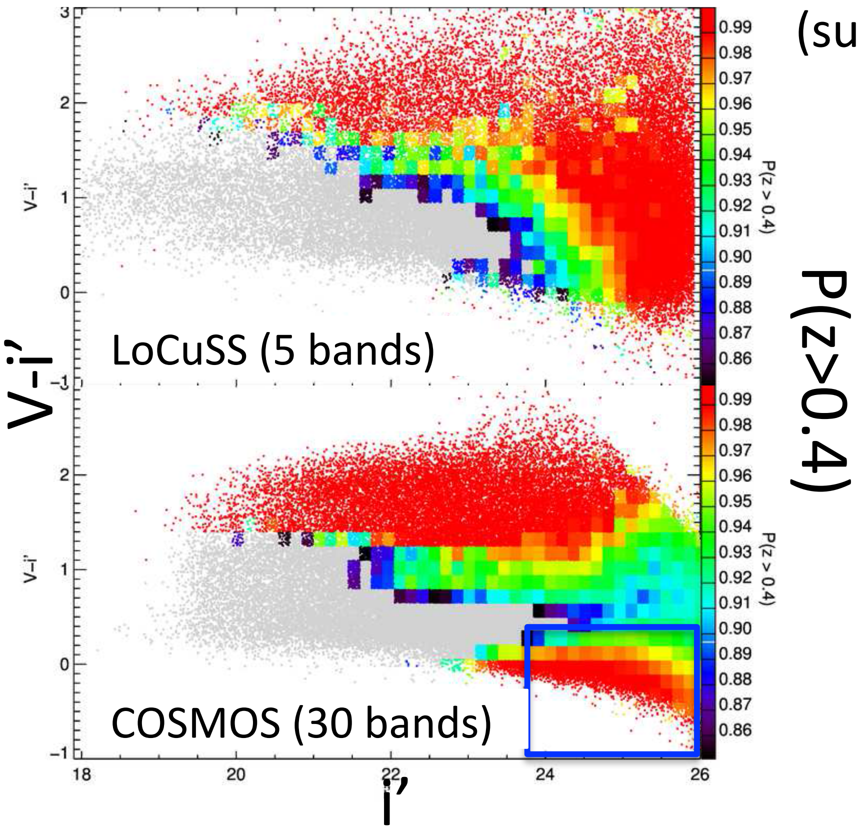


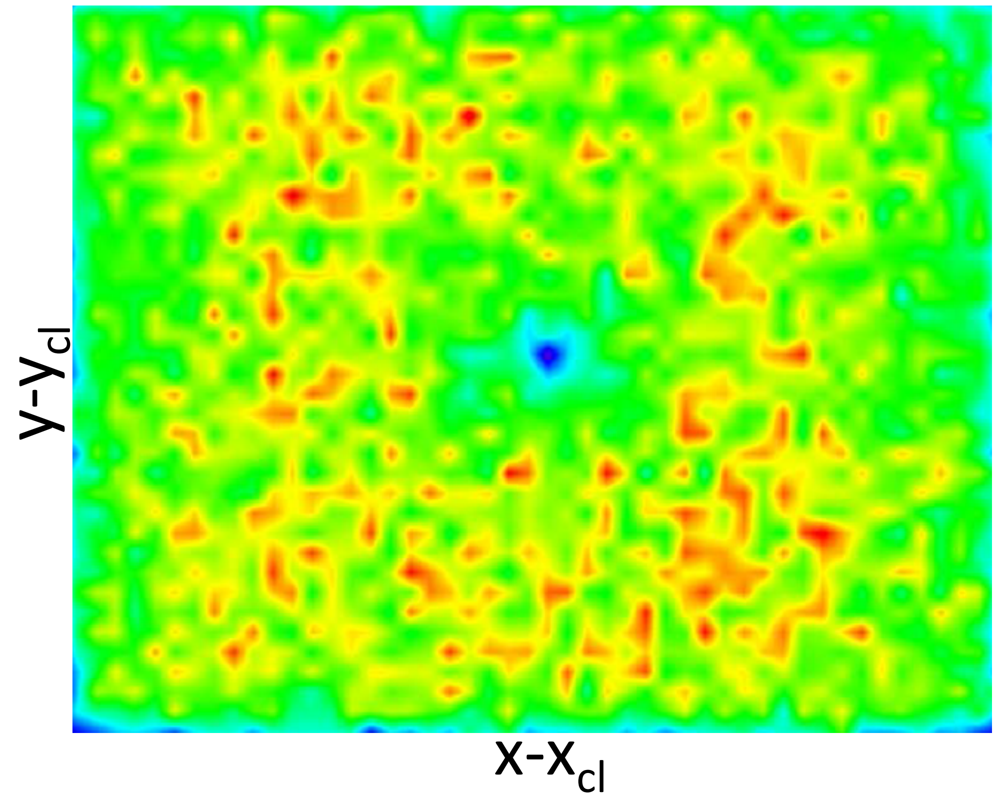
UNIVERSITY OF MICHIGAN

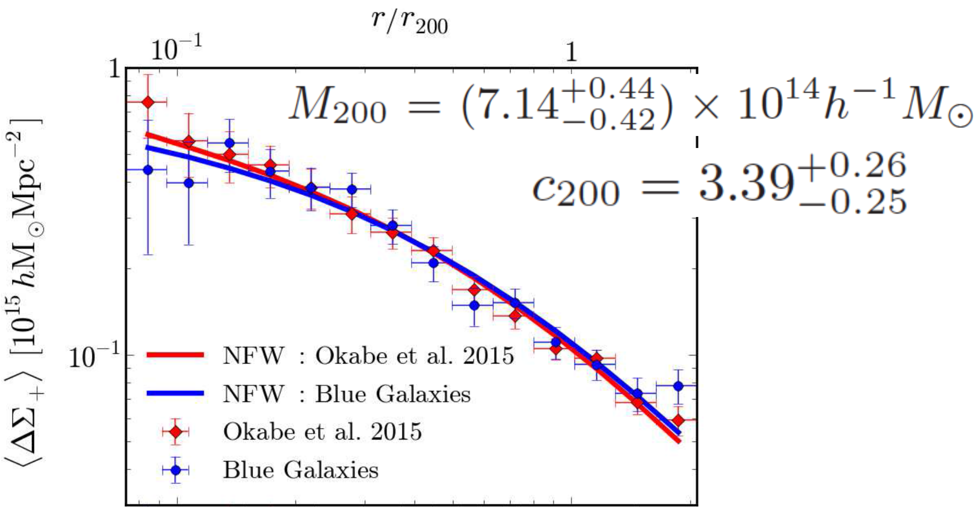
LoCuSS: Exploring the selection of blue background galaxies for cluster weak-lensing

F. Ziparo, G. P. Smith, N. Okabe, C. P. Haines, M. J. Pereira, E. Egami

(submitted to MNRAS)







LoCuSS and COSMOS combined to select blue background galaxies. We obtain:

- Stacked mass and concentration consistent with red galaxy selection (1% contamination)
- Number density profile consistent with magnification lens bias (not flat)