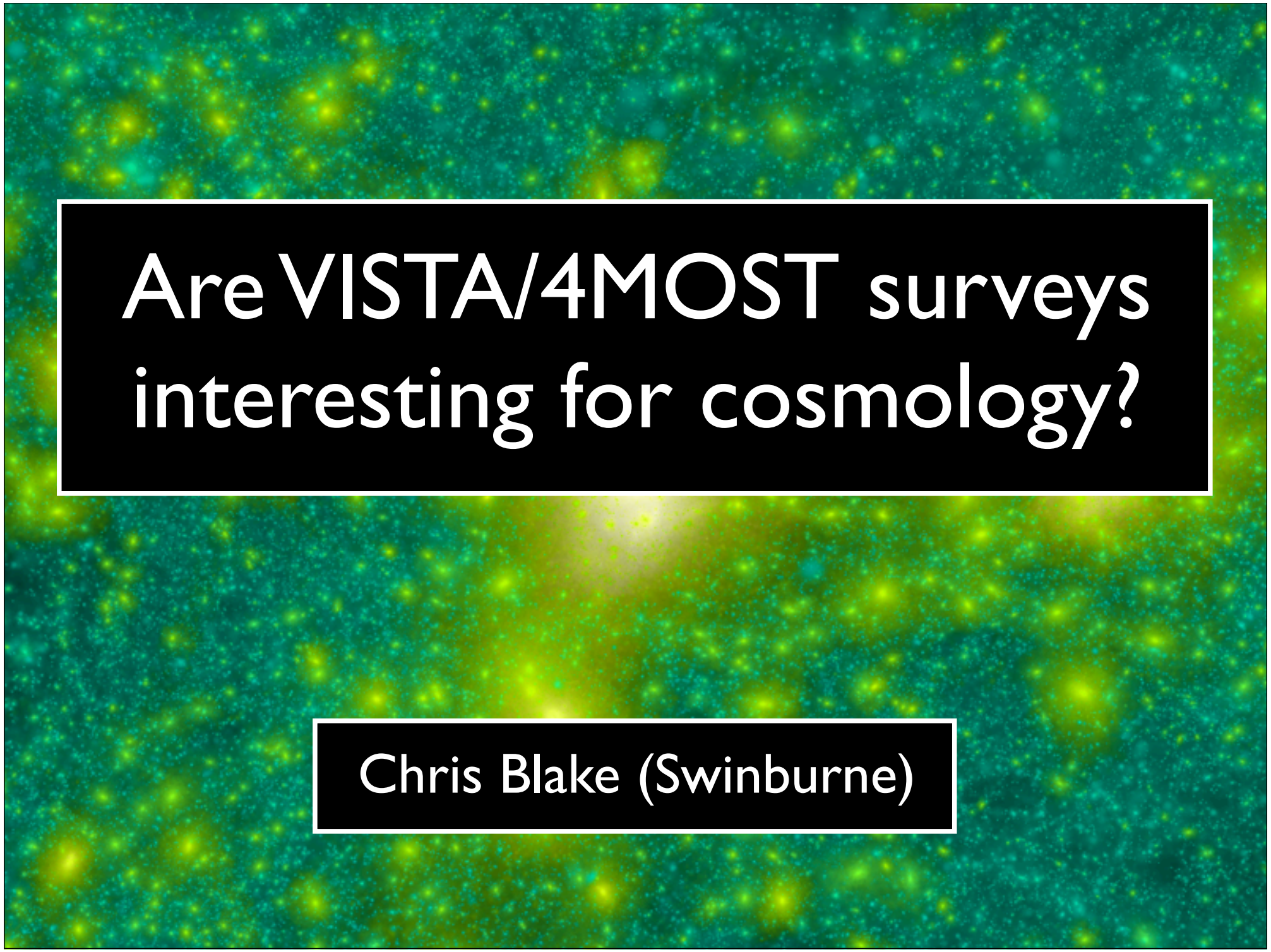
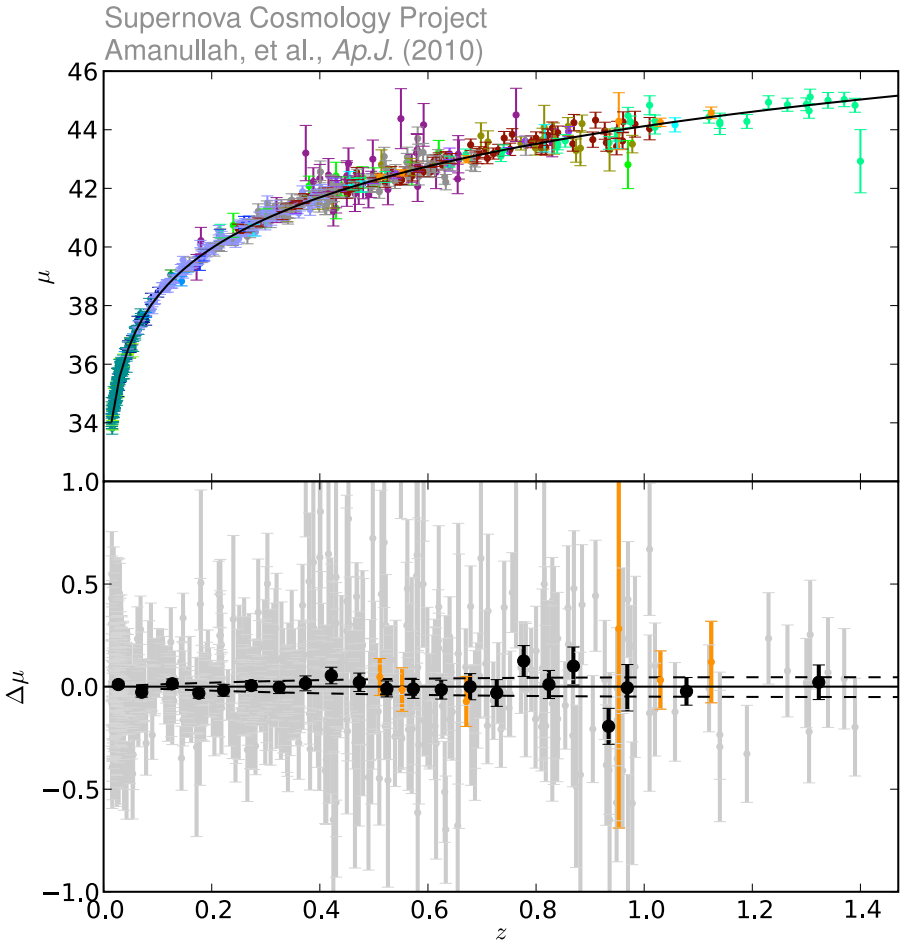

Are VISTA/4MOST surveys interesting for cosmology?
Chris Blake (Swinburne)

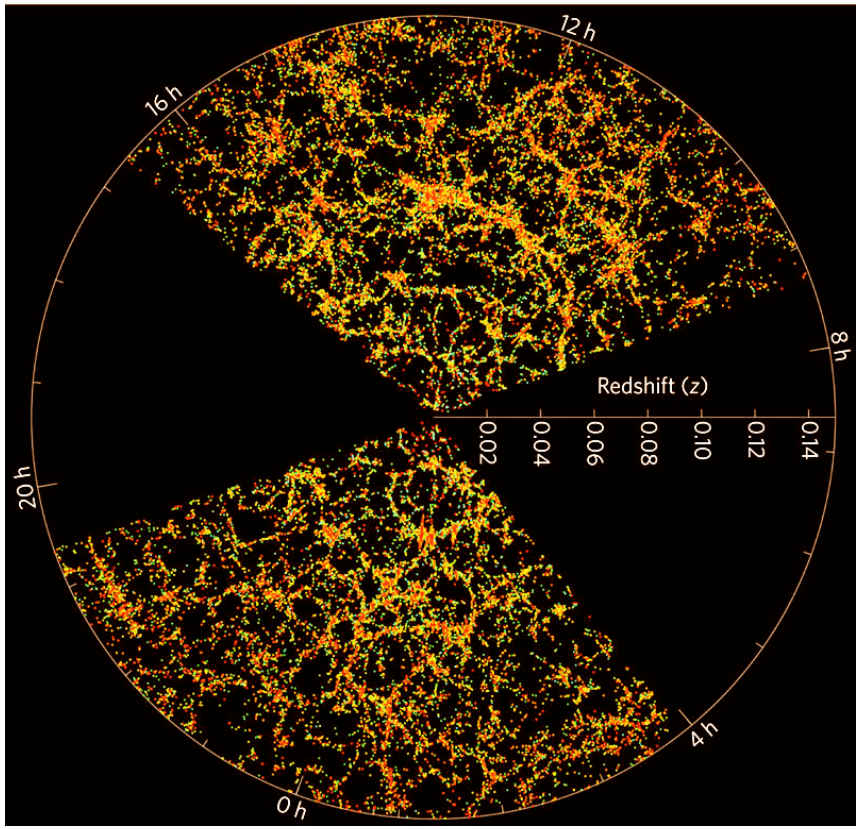
Yes!

Probes of the cosmological model

How fast is the Universe expanding with time?

How fast are structures growing within it?

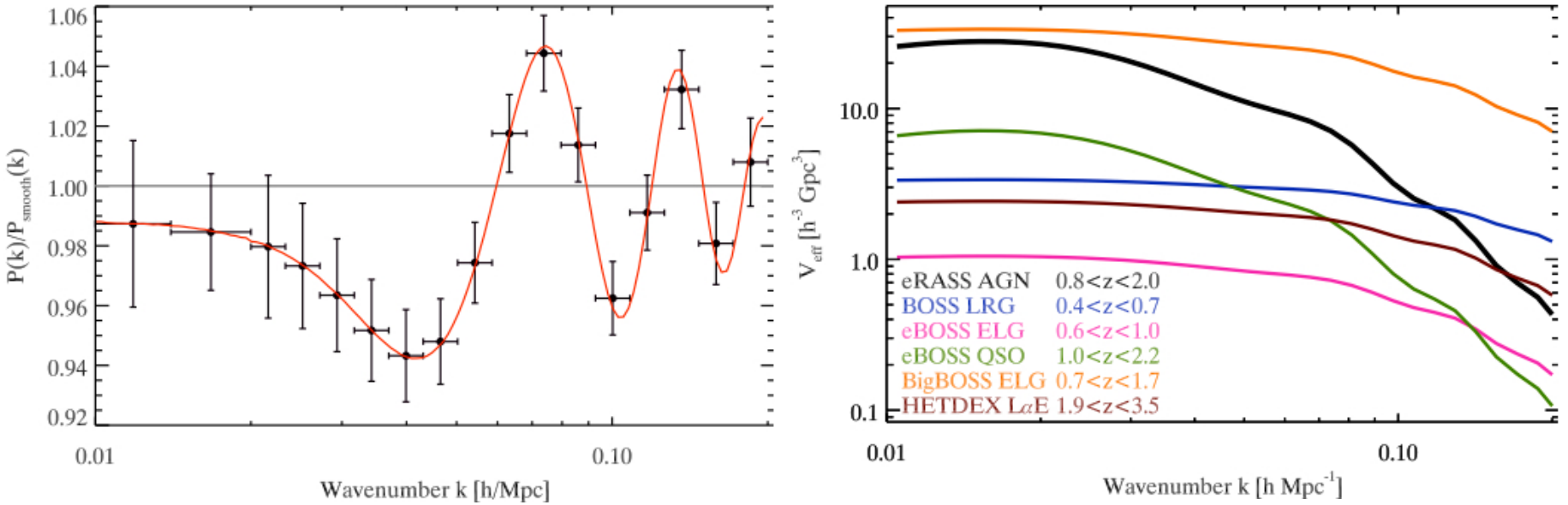




4MOST BAO surveys

- Follow-up ~2x10^6 X-ray selected AGN from eROSITA?

From eROSITA Bulletin 4:



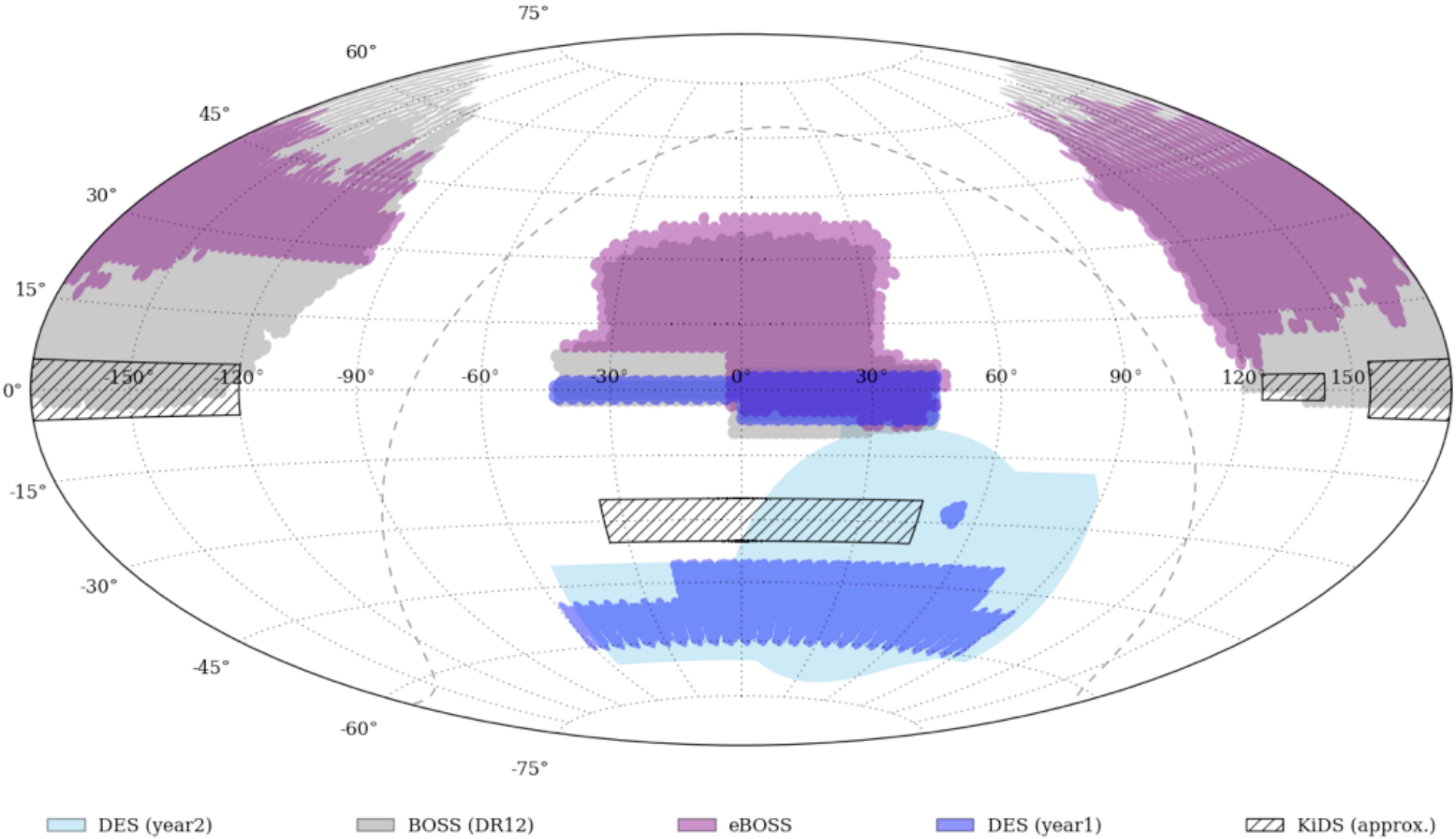
Left: BAO signal in the angular power spectra of eRASS AGN for the redshift interval z = 0–3, shown as residual with respect to a smooth broad-band spectral template. Error bars show statistical uncertainty in the angular power spectrum of the eRASS AGN. In this redshift range the BAO signal will be detected with a 14σ statistical confidence. Right: Effective volumes of various BAO surveys as a function of wavenumber computed for the redshift ranges indicated in the plot.

4MOST BAO surveys

- The sample is very under-dense for BAO studies (issues : shot noise, reconstruction)
- Comparison : DESI is targetting 18×10^6 ELGs, 4×10^6 LRGs, 3×10^6 QSOs on a similar timeframe (2018-22)
- Other strong competition from Euclid and WFIRST
- Suggests that BAO studies targetting this AGN sample are likely not competitive?
- But ...

4MOST lensing follow-up surveys

- Mis-match between imaging and spectroscopy

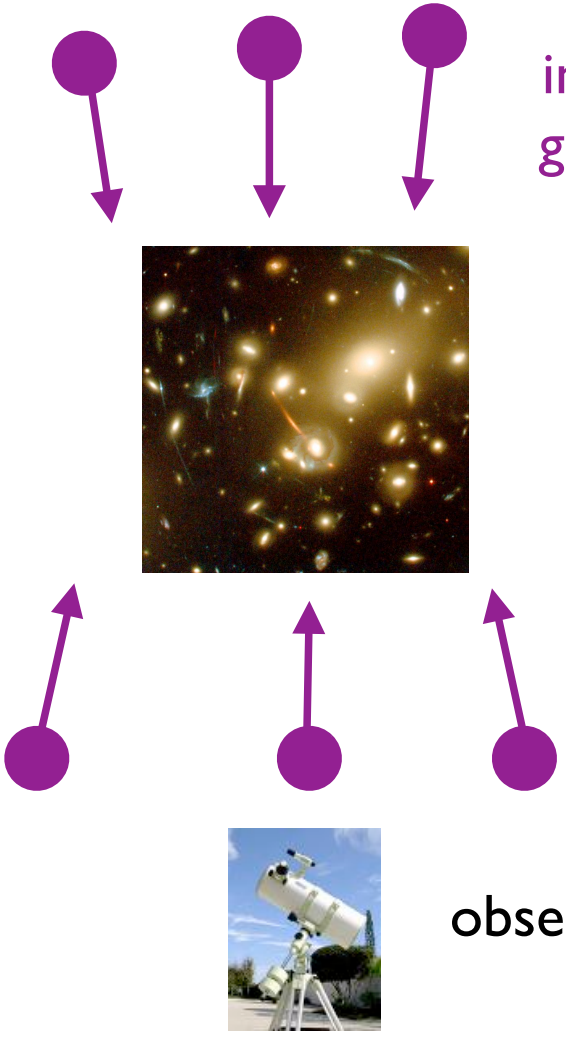


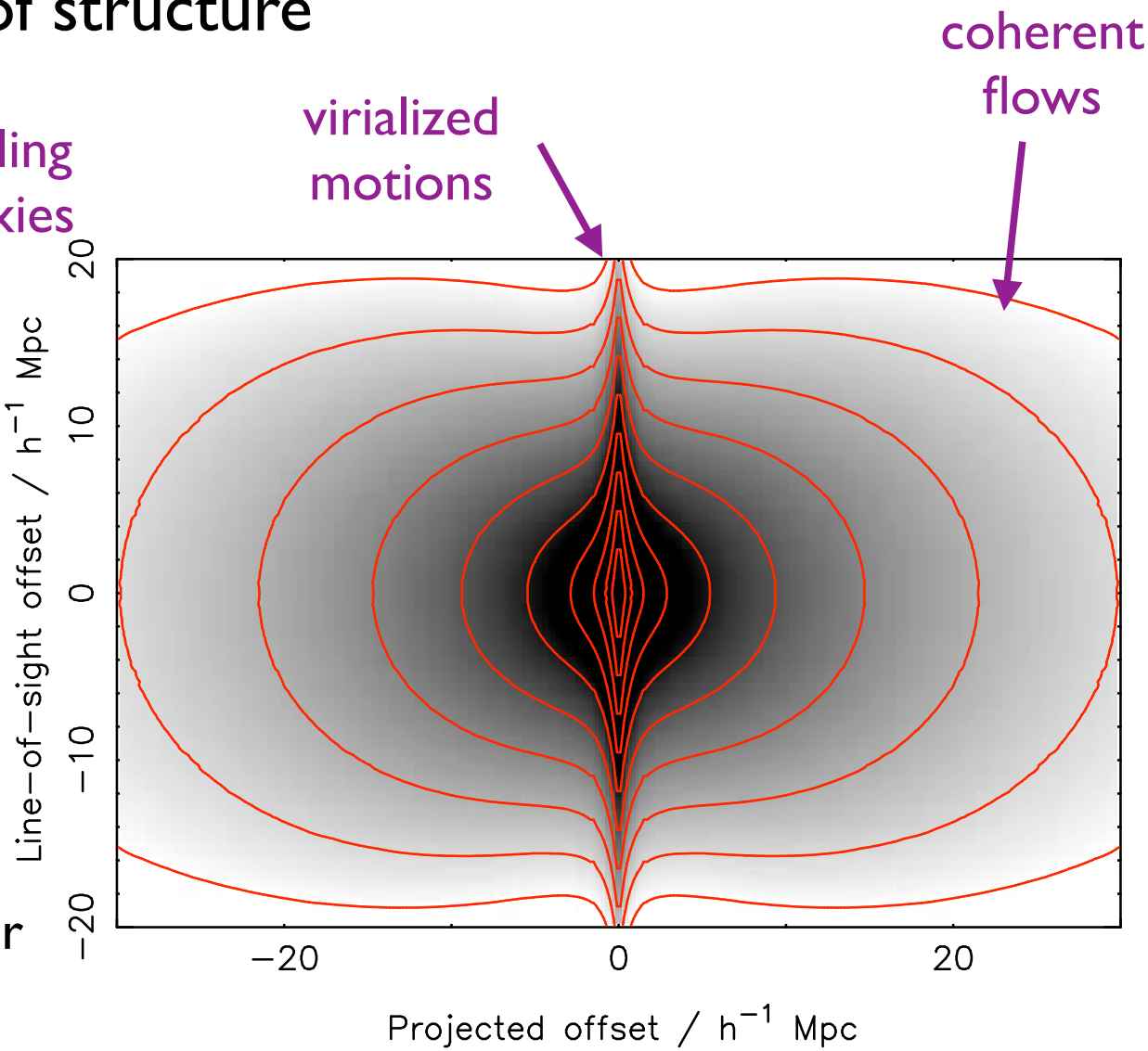
Overlaps of lensing and spec-z surveys

- Improvement of cosmological measurements through addition of galaxy-galaxy lensing
- [e.g. determines bias of lens sample which improves RSD measurements of lenses, especially when using multiple-tracer techniques, e.g. Cai & Bernstein (2012)]
- Spec-z survey allows definition of lens samples (e.g. groups, galaxy types) enabling a range of studies
- Understanding, calibration and risk mitigation of systematic errors (photo-z errors including outliers, intrinsic alignments, cosmic shear)

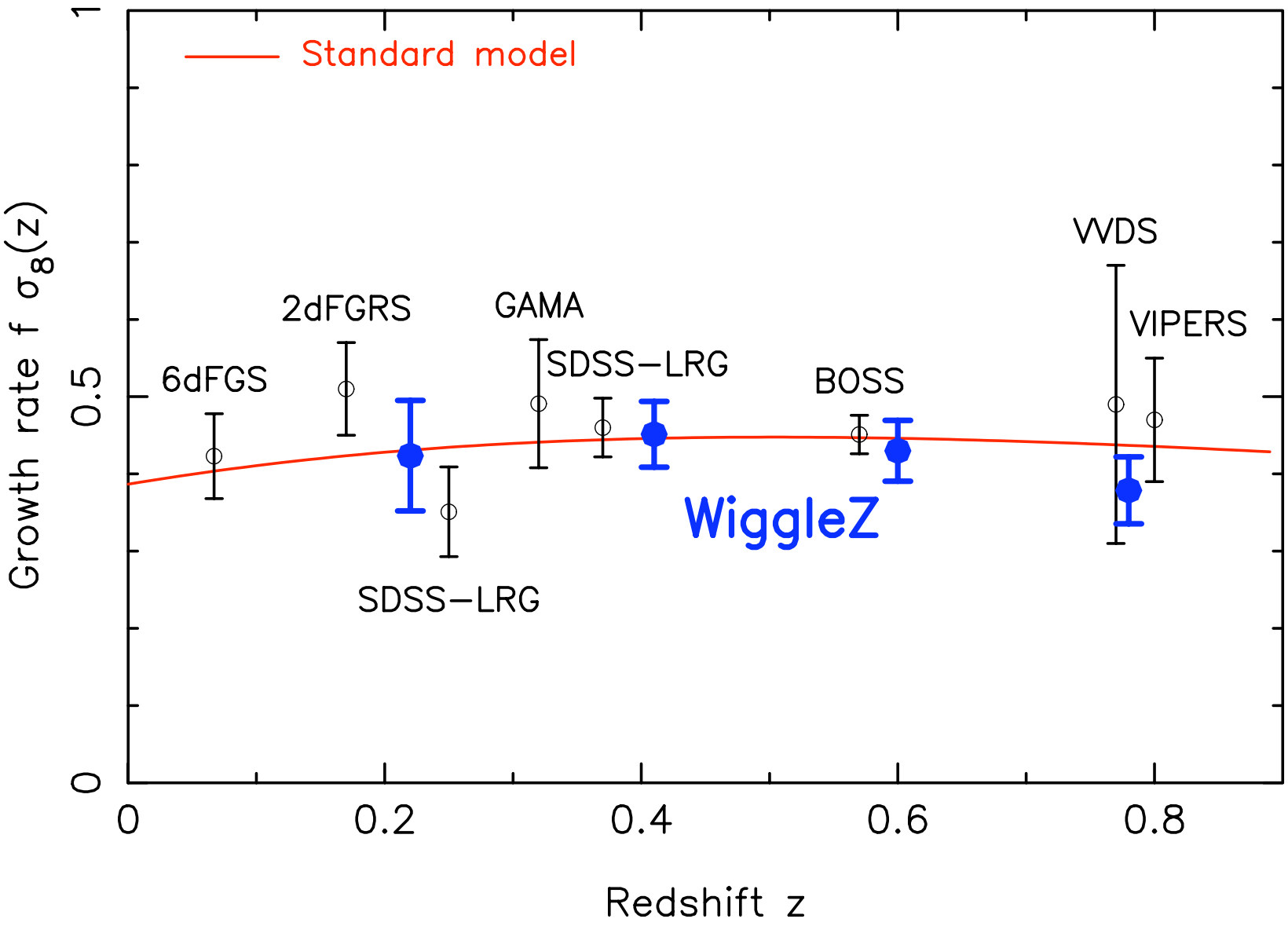
Redshift-space distortions

- RSD allow spectroscopic galaxy surveys to measure the growth rate of structure





Redshift-space distortions



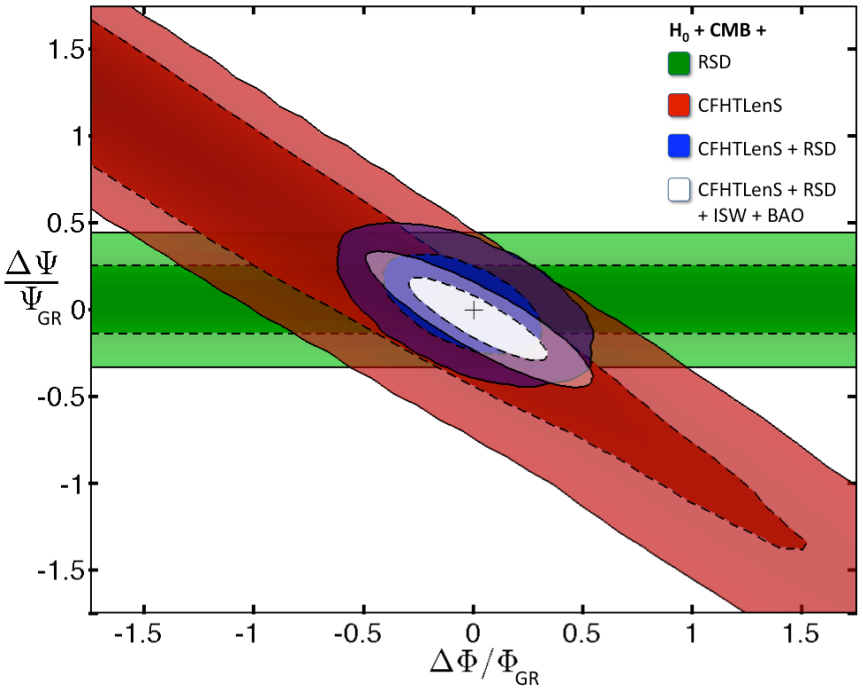
Why combination of lensing and RSD?

- Sensitive to theories of gravity in complementary ways
- General perturbations to FRW metric:

$$ds^2 = [1+2\psi(x,t)]\,dt^2 - a^2(t)\,[1-2\phi(x,t)]\,dx^2$$

- (ψ, ϕ) are metric gravitational potentials, identical in General Relativity but can differ in general theories
- Relativistic particles (e.g. light rays for lensing) collect equal contributions and are sensitive to $(\psi + \phi)$
- Non-relativistic particles (e.g. galaxies infalling into clusters) experience the Newtonian potential ψ

Applications



arXiv:1003.2185

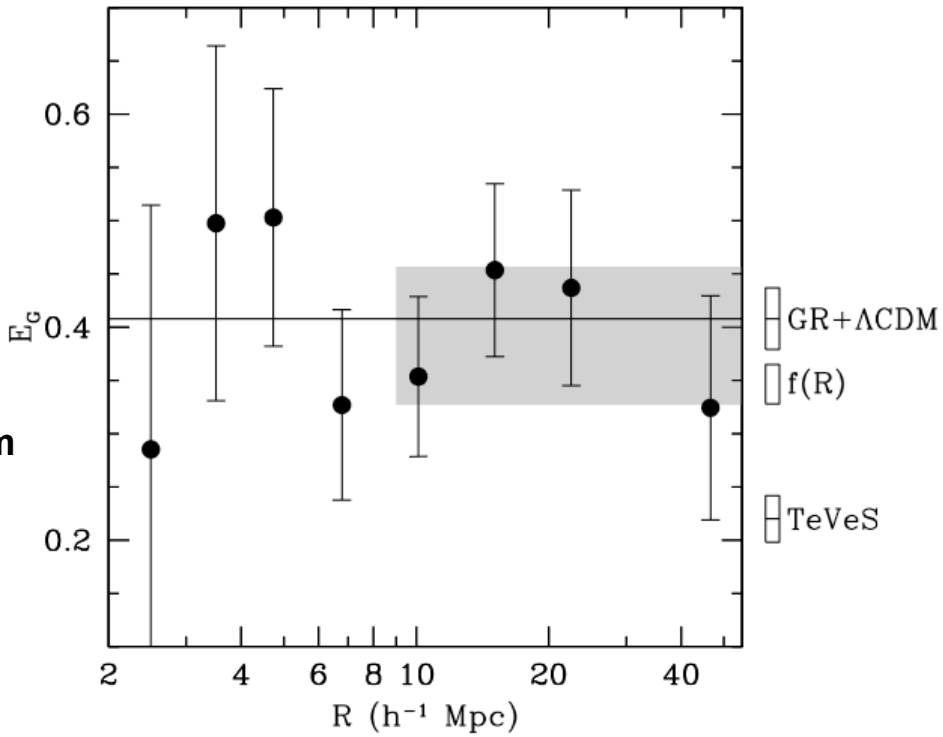
Confirmation of general relativity on large scales from weak lensing and galaxy velocities[1]

Reinabelle Reyes[1], Rachel Mandelbaum[1], Uros Seljak[2-4], Tobias Baldauf[2], James E. Gunn[1], Lucas Lombriser[2], Robert E. Smith[2]

arXiv:1212.3339

CFHTLenS: Testing the Laws of Gravity with Tomographic Weak Lensing and Redshift Space Distortions

Fergus Simpson[1⋆], Catherine Heymans[1], David Parkinson[2], Chris Blake[3], Martin Kilbinger[4,5,6], Jonathan Benjamin[7], Thomas Erben[8], Hendrik Hildebrandt[7,8], Henk Hoekstra[9,10], Thomas D. Kitching[1], Yannick Mellier[11], Lance Miller[12]

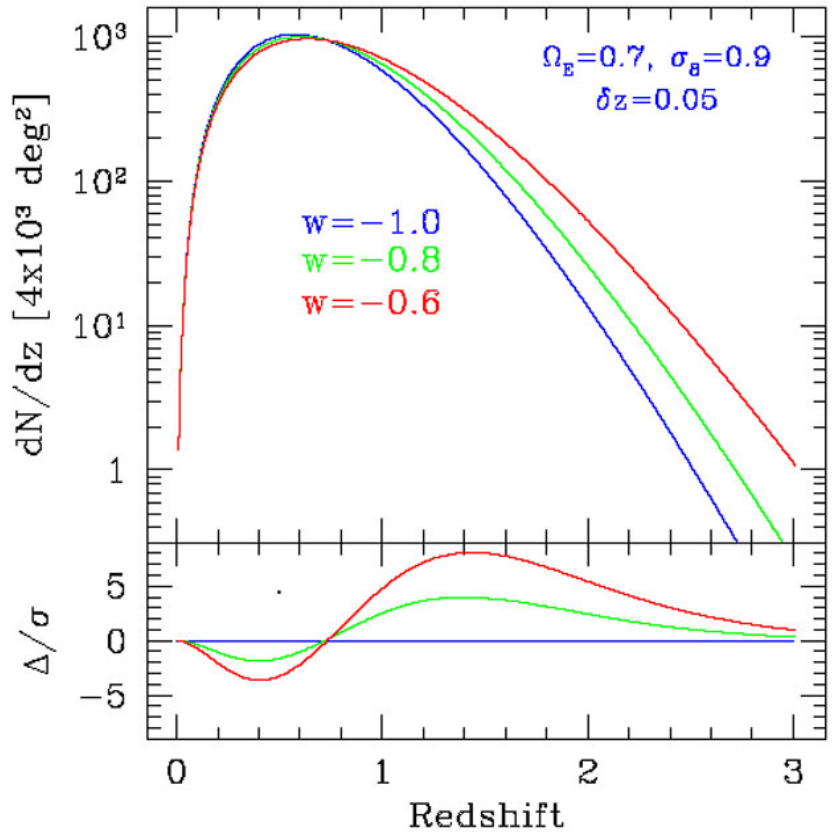


Photometric redshift calibration

- Photometric redshift errors are one of the leading systematics for weak lensing tomography
- Mean and width of redshift distributions in each photo-z bin must be known to accuracy ~ 10^{-3}
- Method (1) : spectroscopic training set [issues : sample variance, incompleteness of training set, outliers]
- Method (2) : photo-z/spec-z cross-correlations [issues : degeneracies with galaxy bias, cosmic magnification]
- Currently unsolved problem for current and future lensing surveys (DES, LSST, Euclid)

Galaxy clusters

- eROSITA will provide deep survey of X-ray clusters
- Mass function of clusters is sensitive test of cosmology
- 4MOST can efficiently obtain cluster redshifts



Summary

- VISTA/4MOST offers wide-field spectroscopic follow-up of the southern sky
- BAO surveys targetting AGN likely not competitive
- Follow-up of southern lensing surveys (DES, LSST) is most compelling cosmology science case (in my view)
- Allows cross-correlations of RSD + cosmic shear and other applications of galaxy-galaxy lensing
- Solves the photometric-redshift calibration problem
- Cluster cosmology