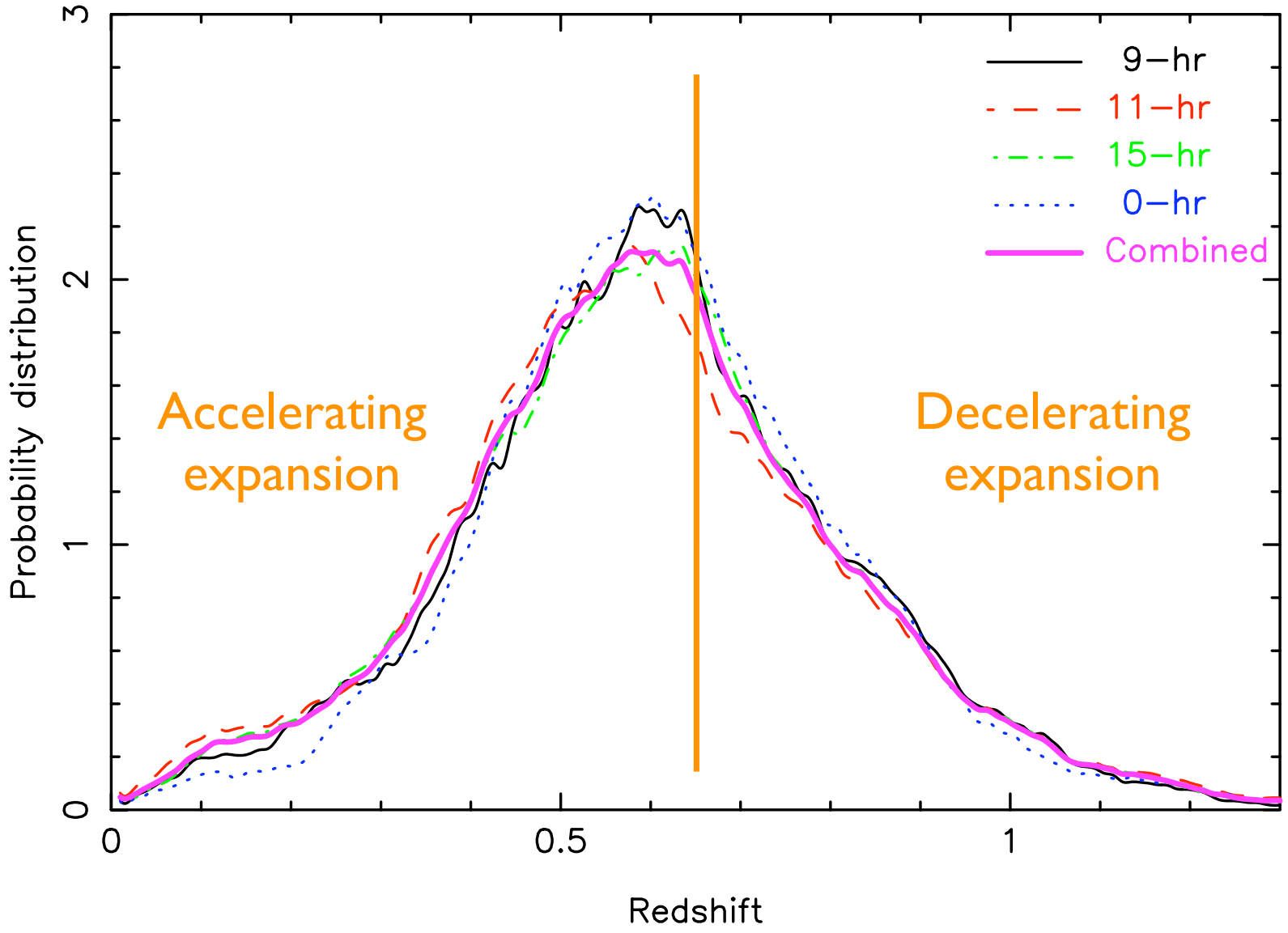
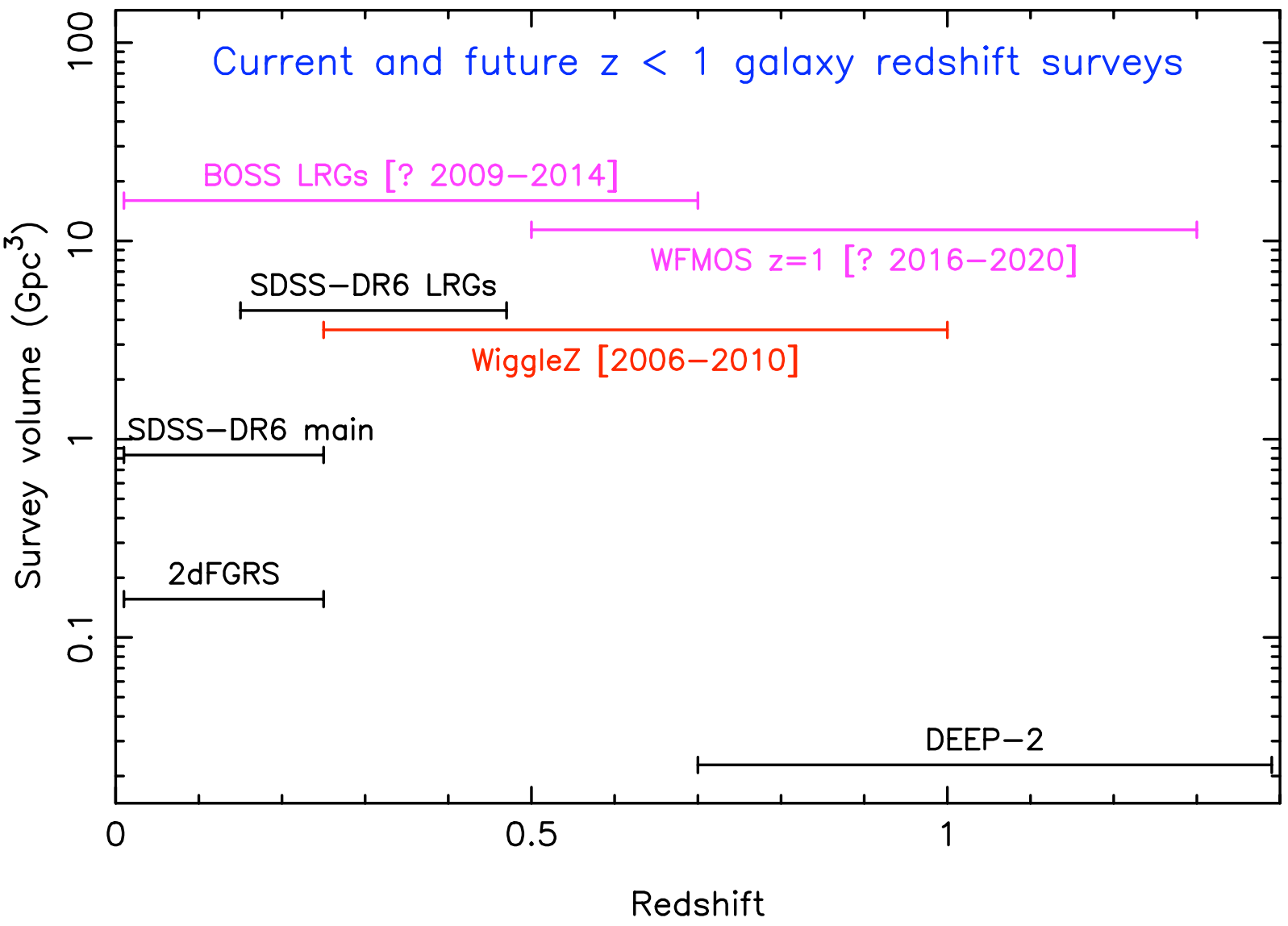
The WiggleZ Dark Energy Survey

- Map ~1 Gpc^3 of the Universe at much higher redshift than existing surveys
- Use baryon oscillations to map the distance-redshift relation to z=1 to allow systematic cross-checks with supernova measurements
- Measure growth of cosmic structure from z=1 to z=0 to test the physical nature of dark energy
- Neutrino mass , homogeneity , bispectrum , Alcock-Paczynski effect , genus , galaxy formation , ...

The WiggleZ Dark Energy Survey



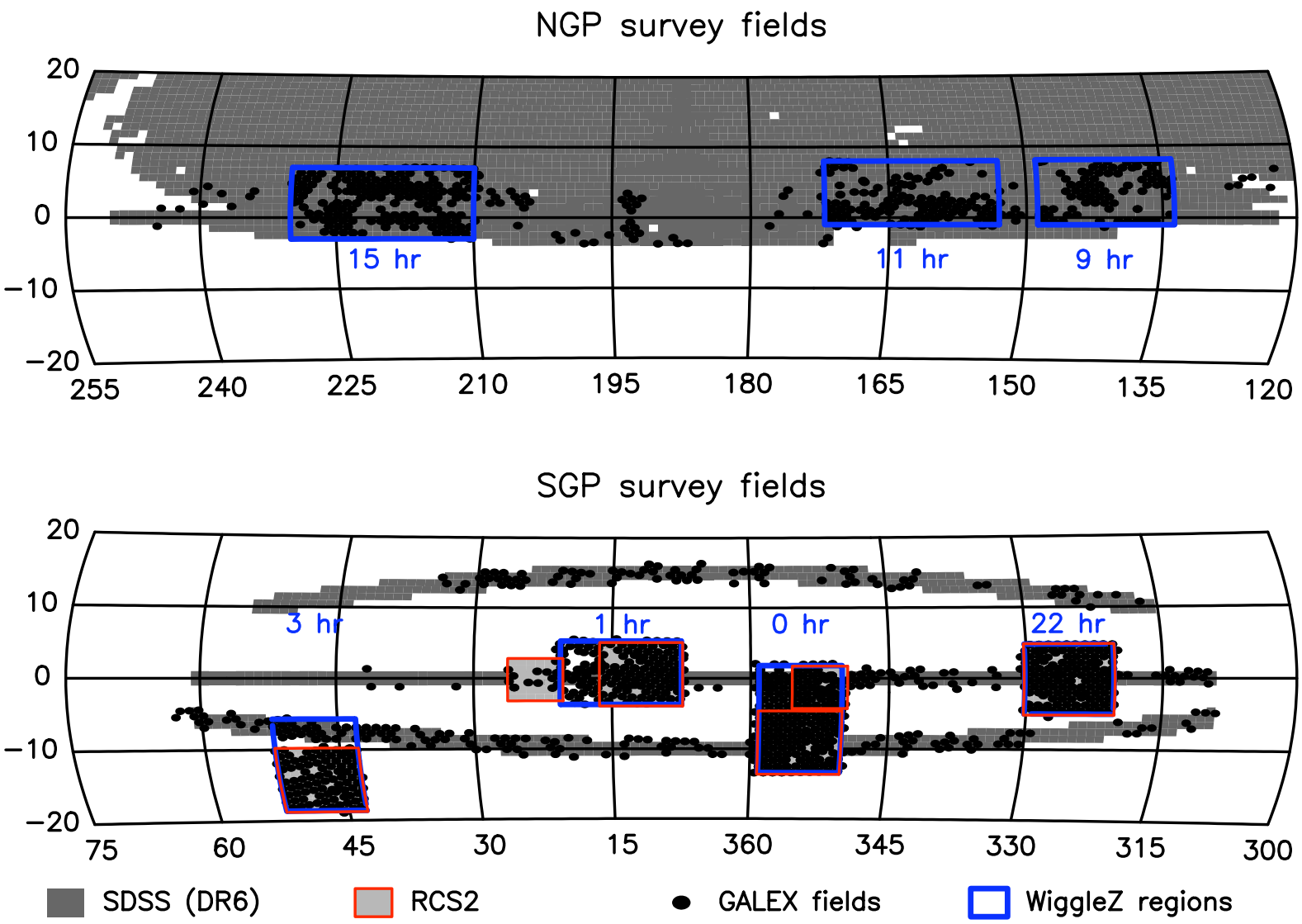
The WiggleZ Dark Energy Survey



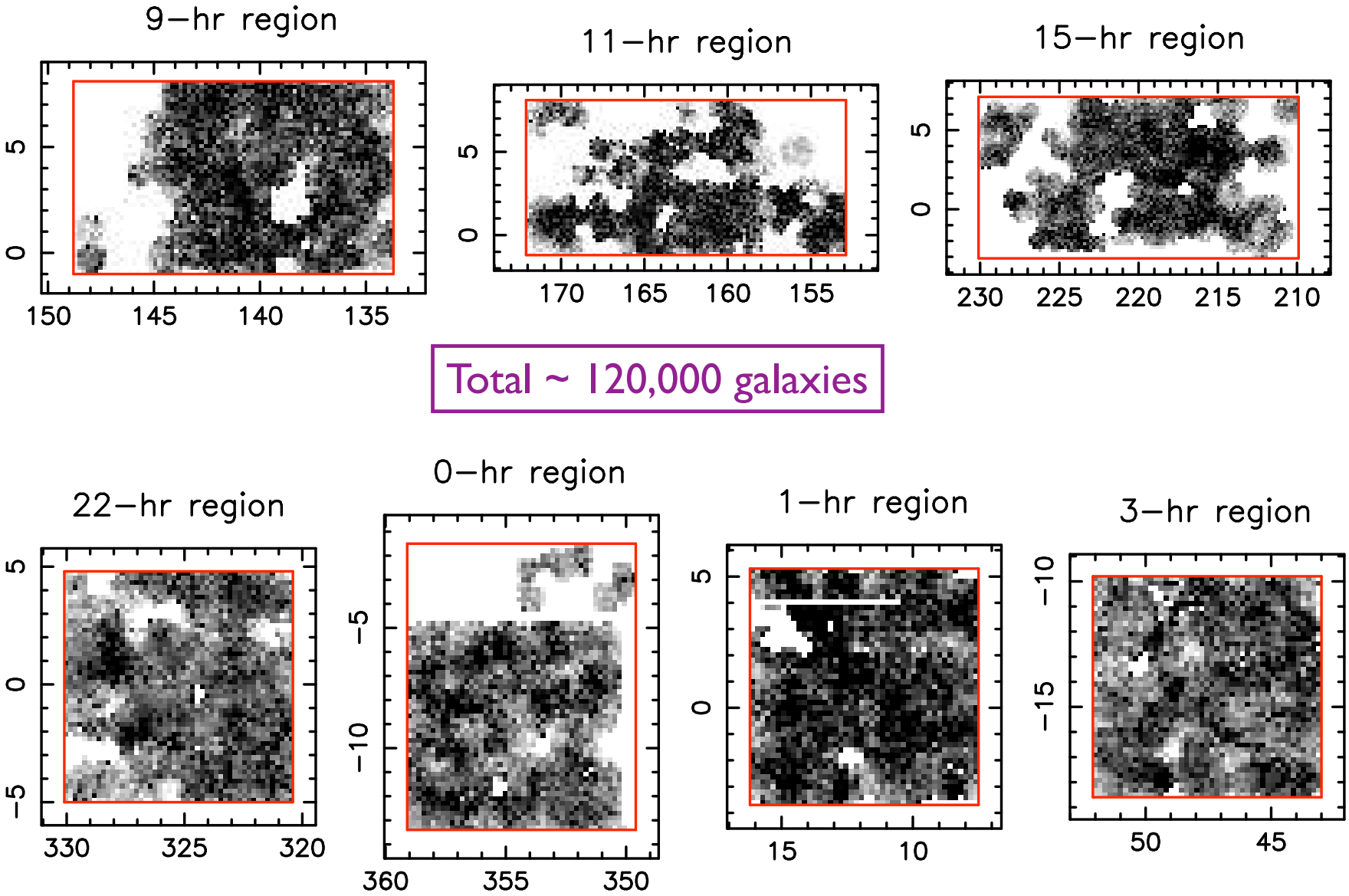
Survey design

- Follow up UV-selected sources from GALEX imaging matched with optical surveys for precise fibre position
- Colour cuts select high-redshift galaxies
- Star-forming galaxies : redshifts from emission lines, star formation rates 10-100 solar masses per year
- Very short 1-hr exposures - maximize numbers tolerating a 70% redshift completeness rate

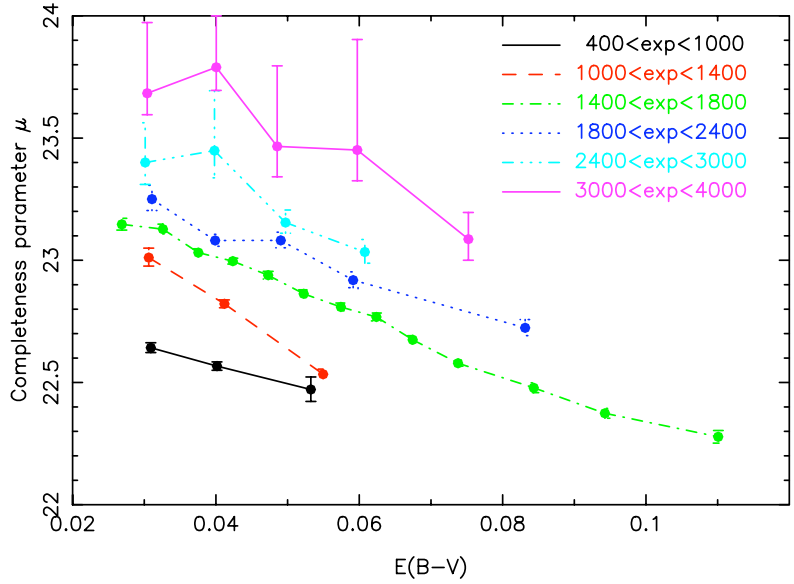
Survey design

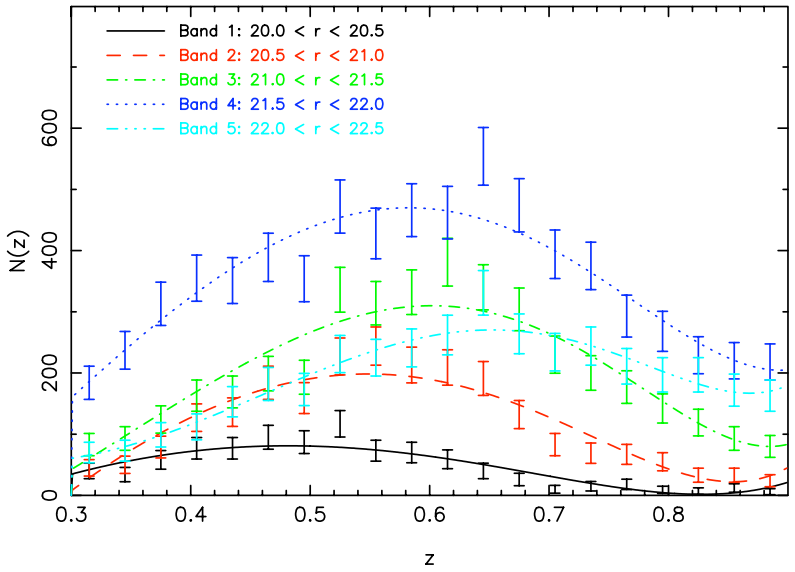


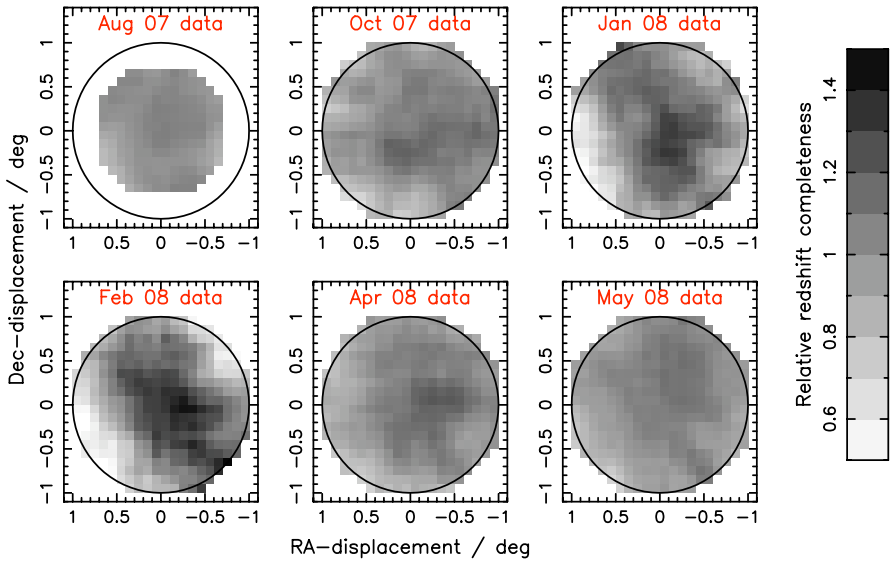
WiggleZ survey regions (Oct 09)

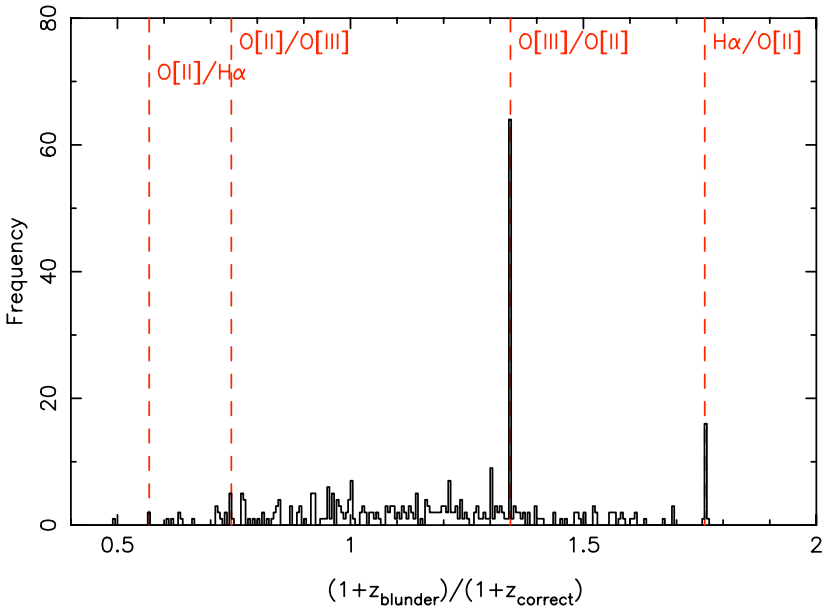


Survey selection function

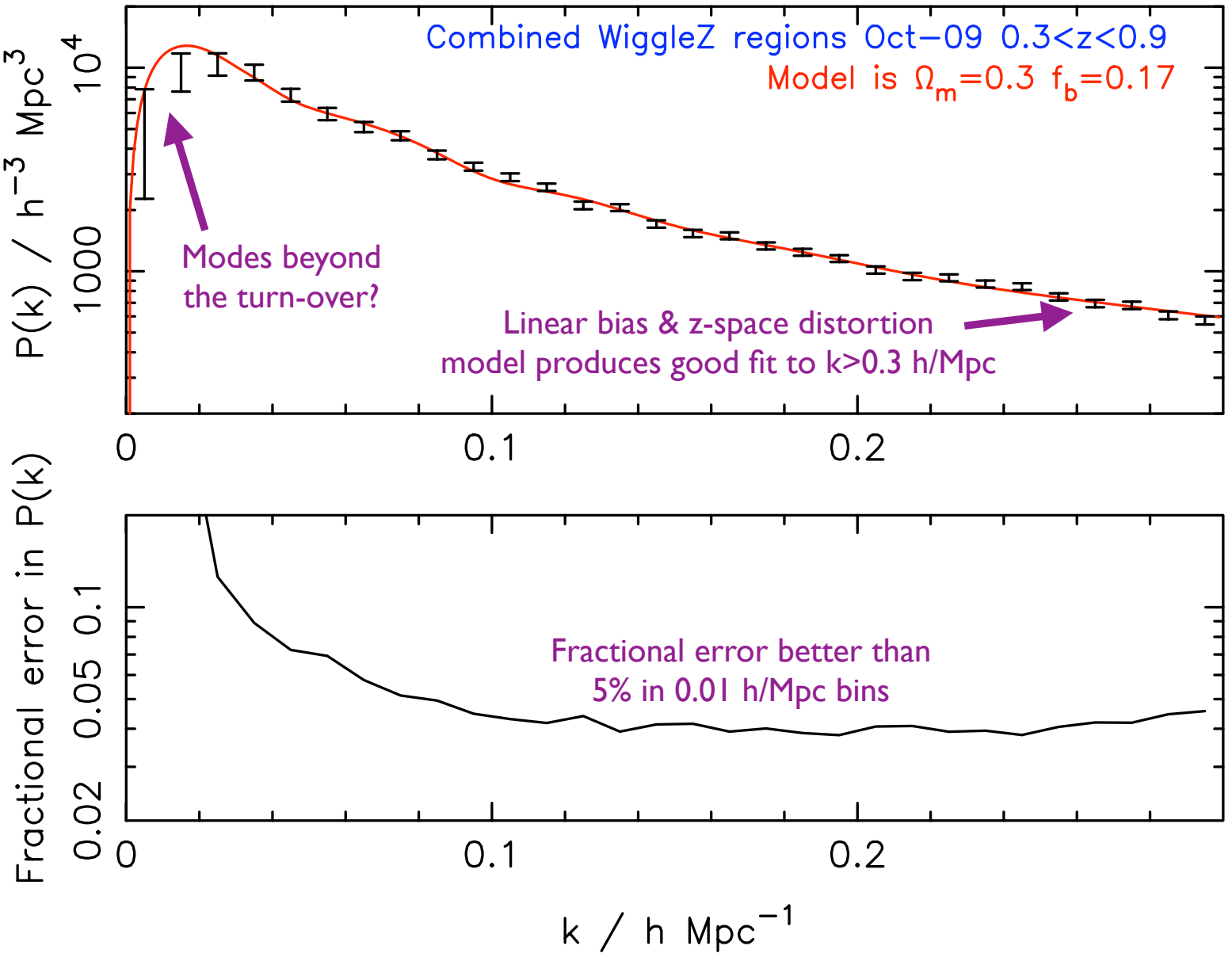




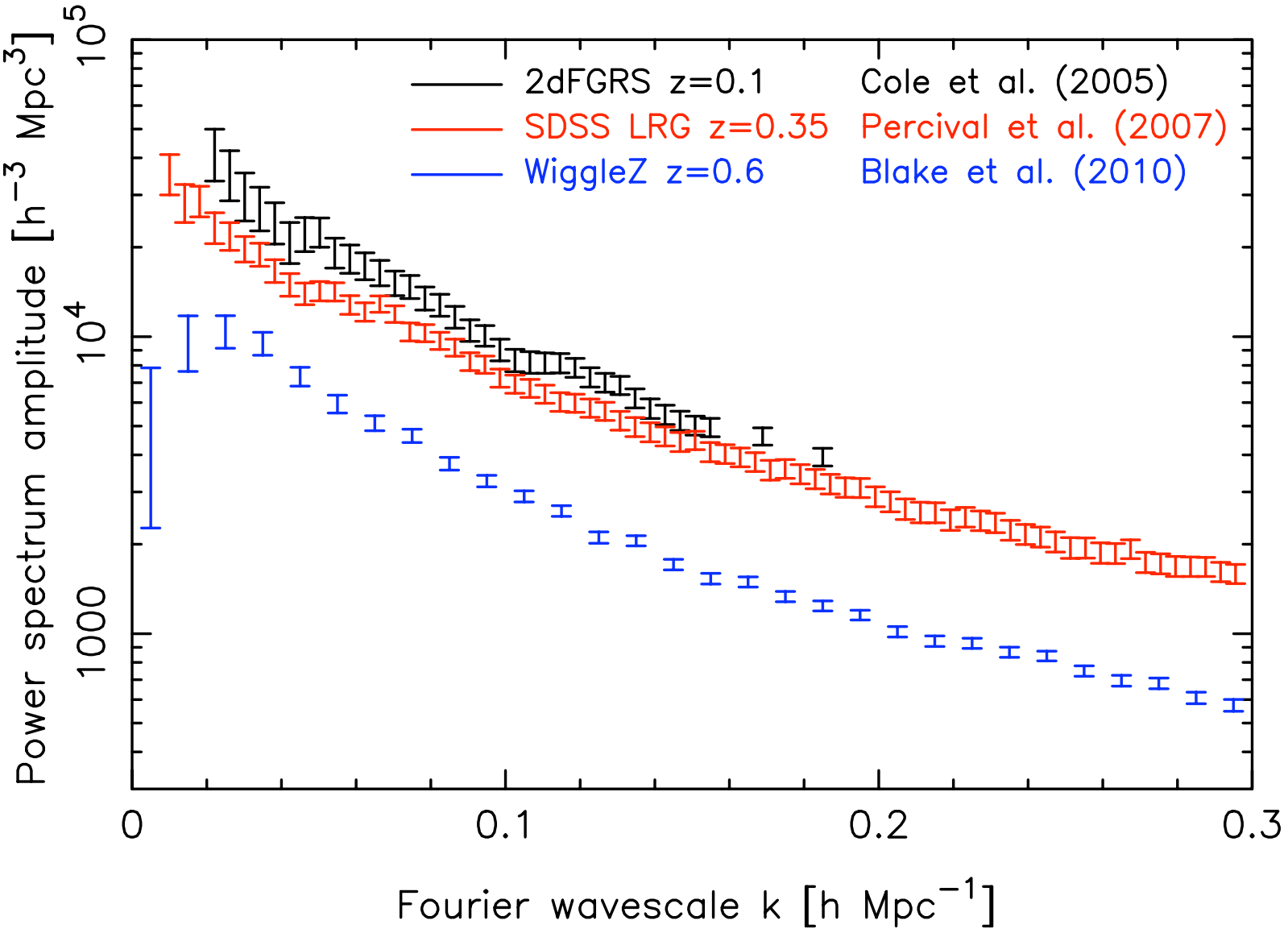




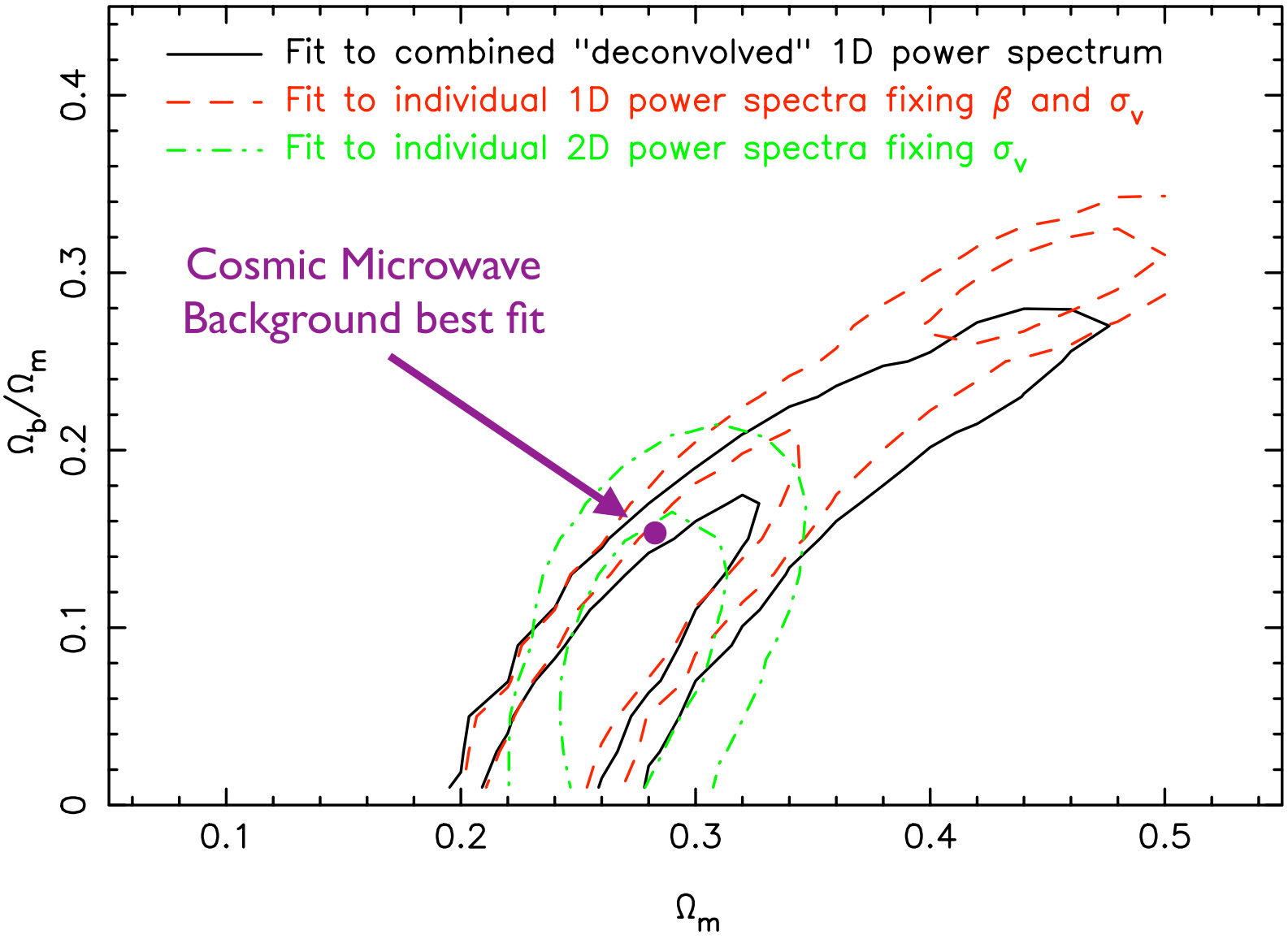
Power spectrum



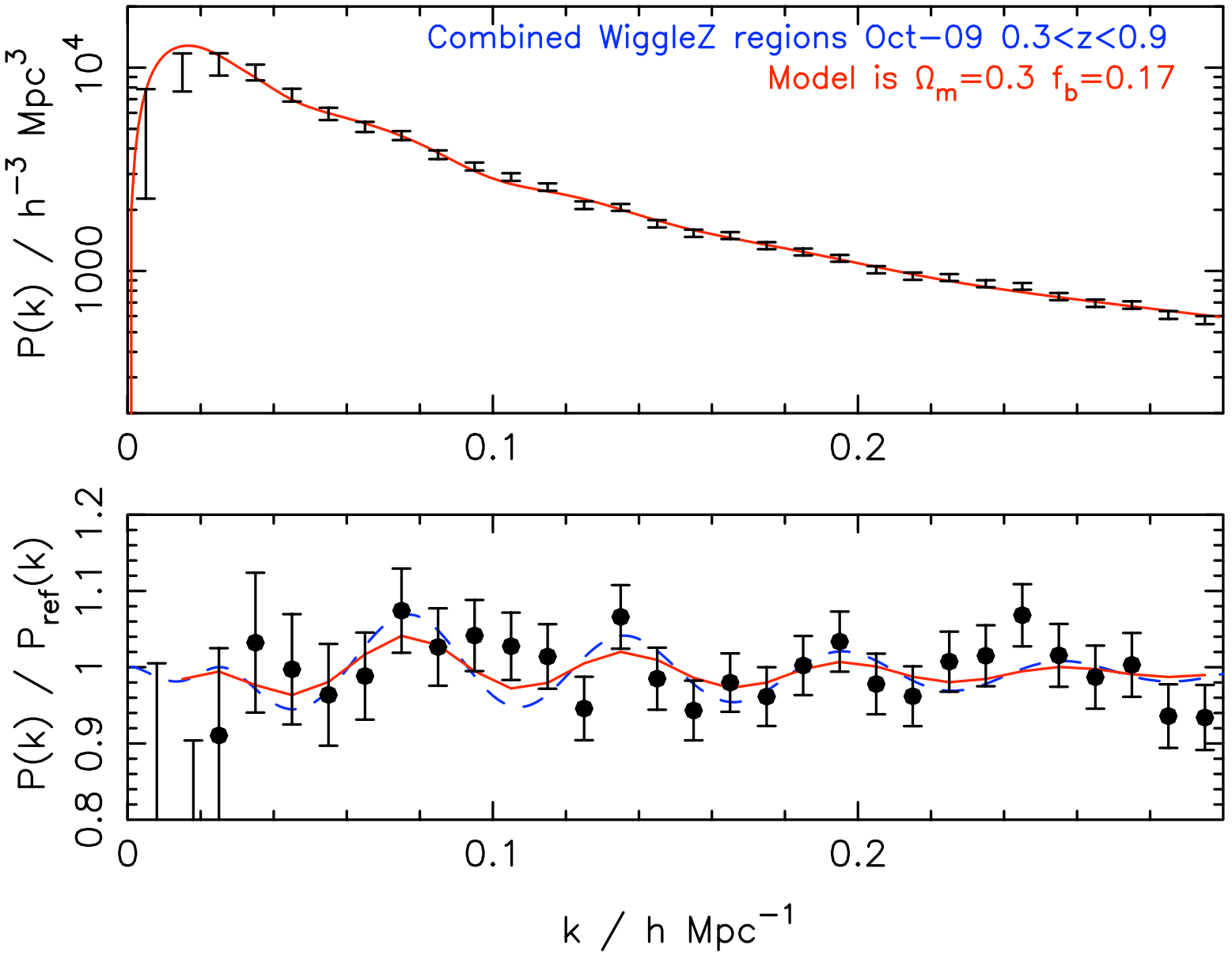
Power spectrum



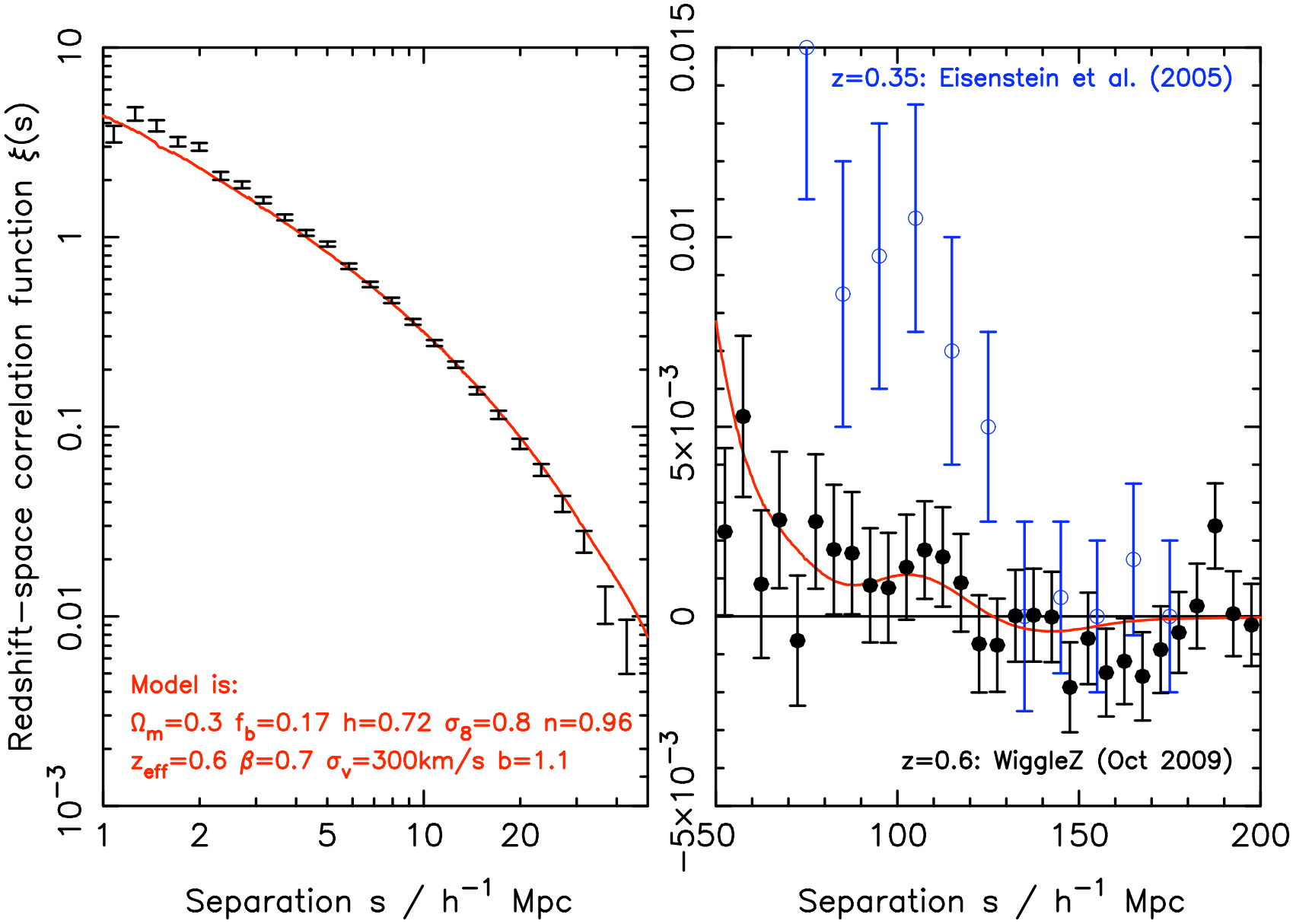
Cosmological parameter fits



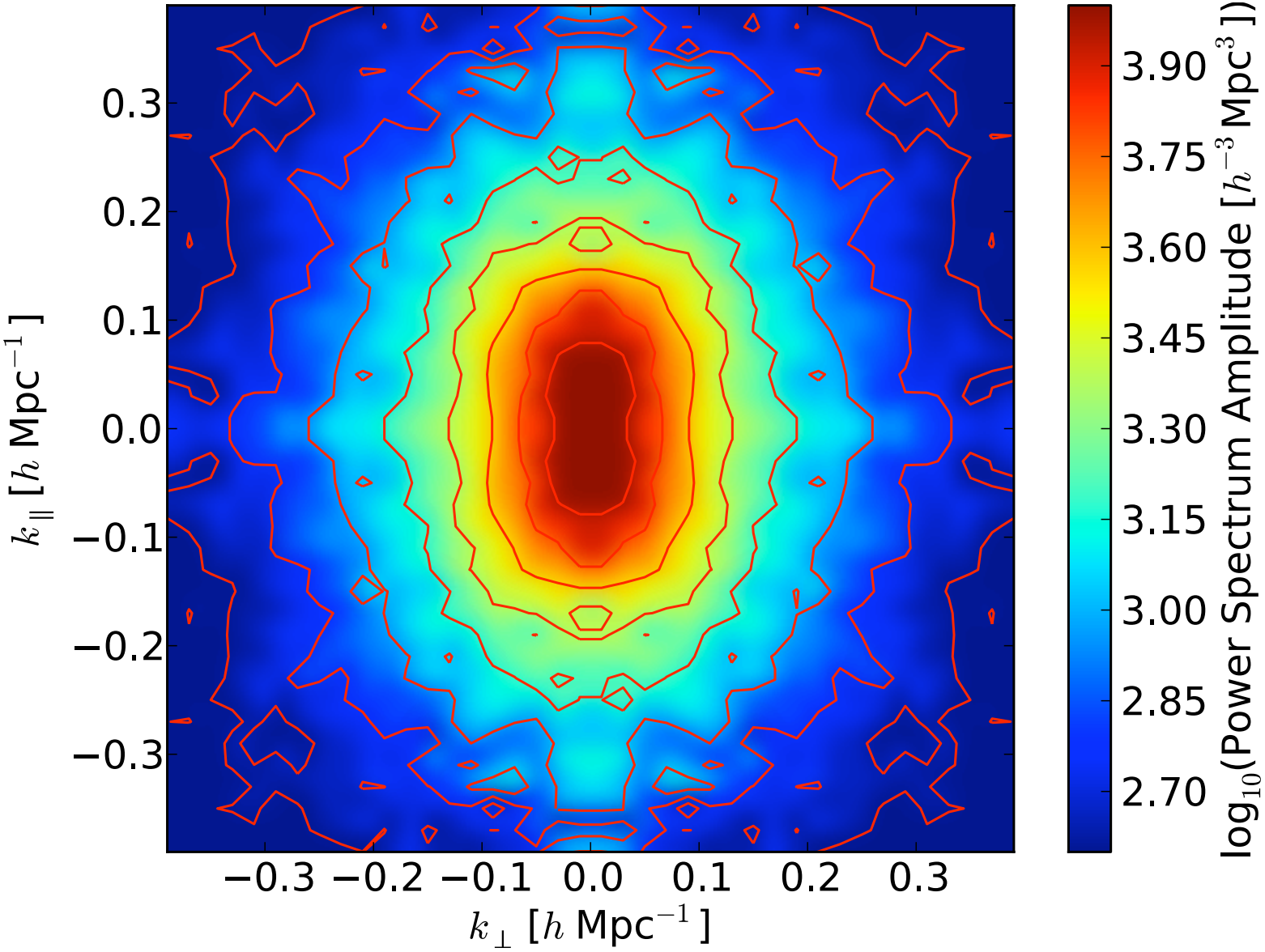
Baryon oscillations?



Baryon oscillations?



Redshift-space distortions



Redshift-space distortions theory

Amplitude of Fourier mode

Growth rate

Angle to the line-of-sight

$\mu = \cos\theta$

$$\delta_s(\vec{k}) = \delta_r(\vec{k})\,(1 + f\,\mu^2)$$

$\gamma \approx 6/11\,(\Lambda\mathrm{CDM})$

$\gamma \approx 11/16\,(\mathrm{DGP})$

$$f = \Omega_\mathrm{m}(z)^\gamma$$

Galaxy power spectrum

Bias factor

Matter power spectrum

$$P_\mathrm{g}(k,\mu) = b^2\,P_\mathrm{m}(k)\left(1 + \frac{f}{b}\mu^2\right)^2$$

3 fitted parameters

Pairwise velocity dispersion

$$P(v) \propto e^{-|v|/\sigma_v}$$

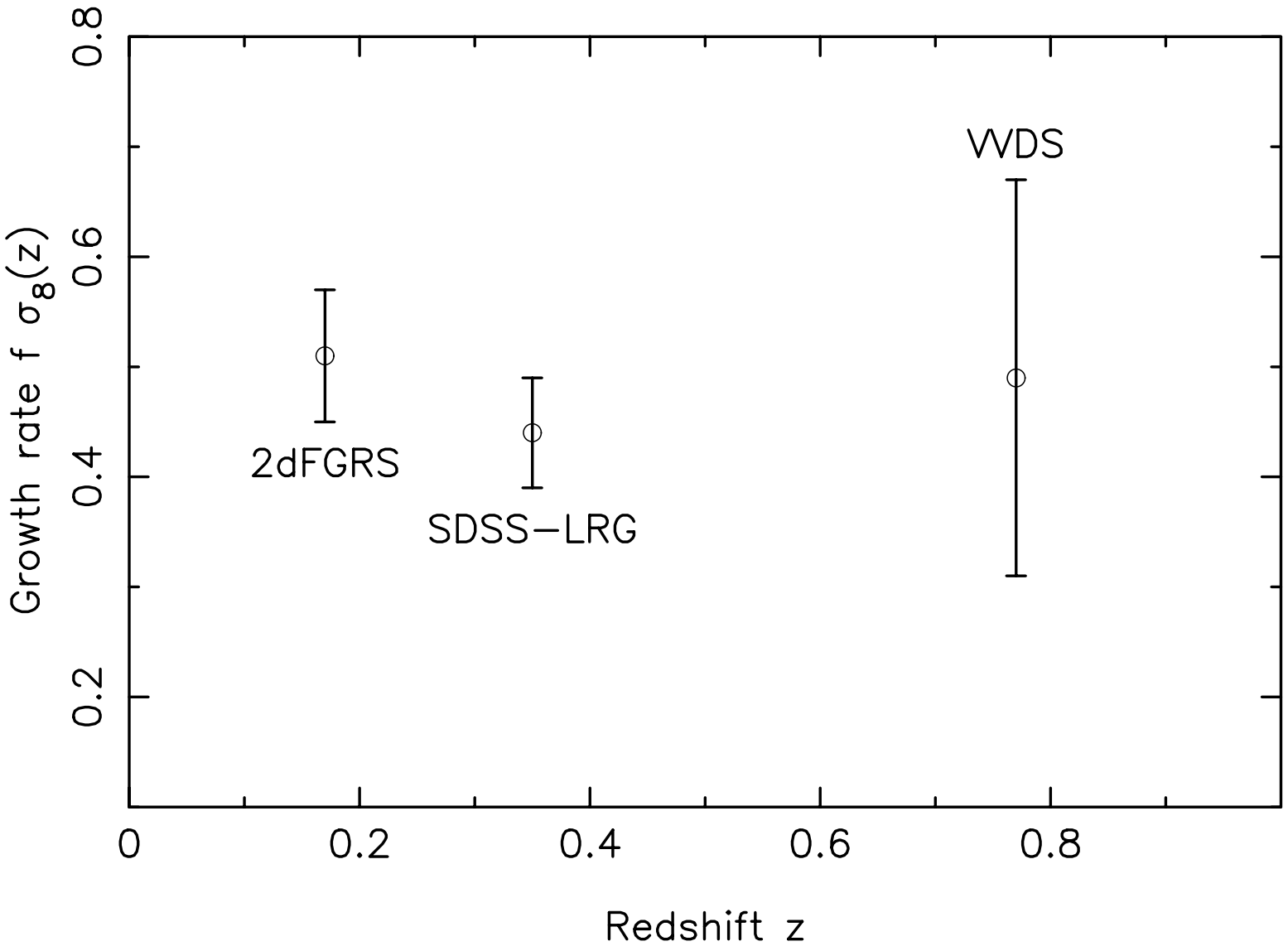
$$P_\mathrm{g}(k,\mu) = b^2\,P_\mathrm{m}(k)\frac{[1 + (f/b)\mu^2]^2}{1 + (\sigma_v H_0 k\mu)^2}$$

Redshift-space distortions theory

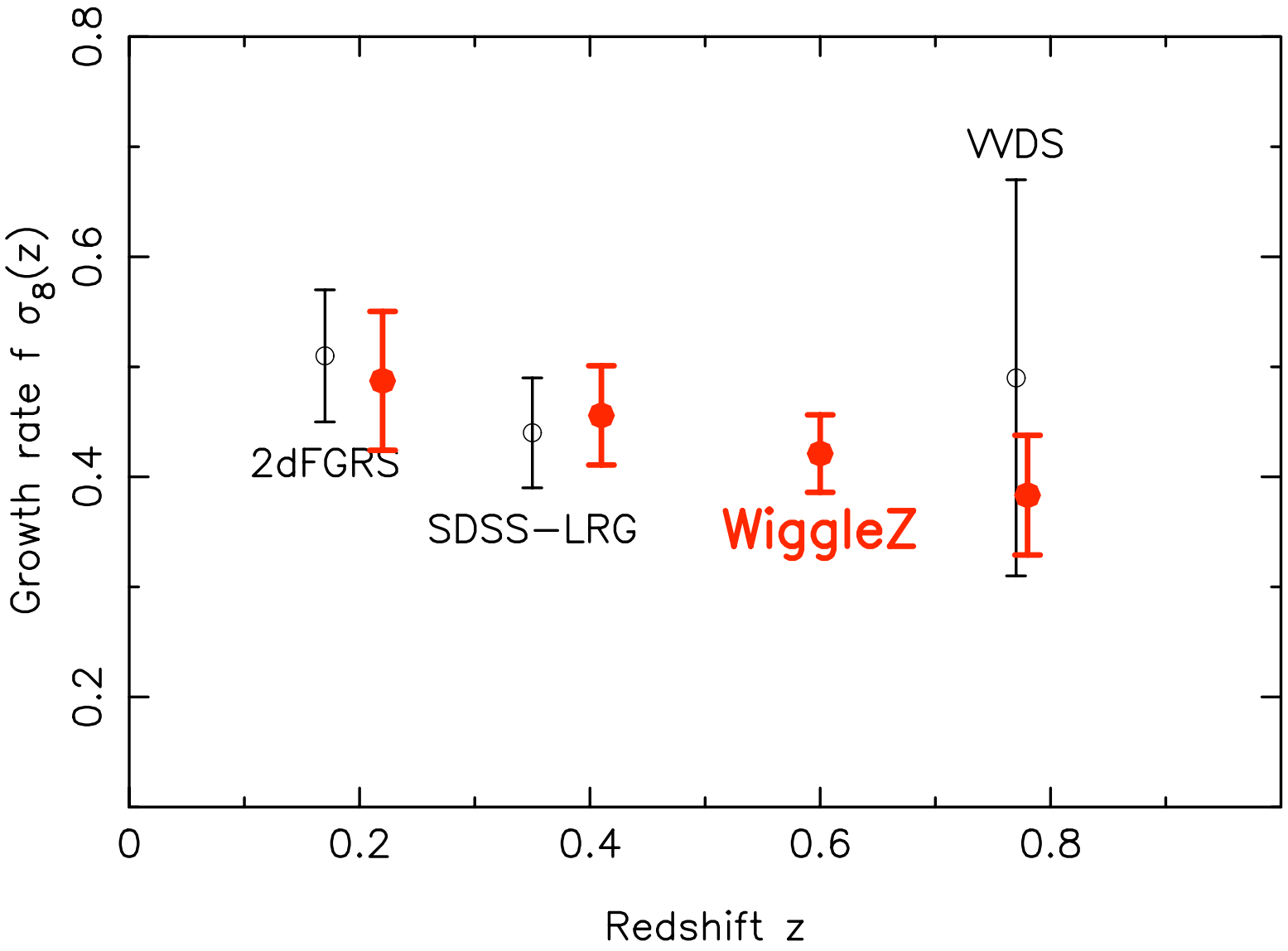
Normalization problem ...

- Galaxy bias b is degenerate with σ_8
- Observable is $f\sigma_8(z)$ not f
- CMB normalization gives us $\sigma_8(z = 1100)$

Growth of structure results



Growth of structure results



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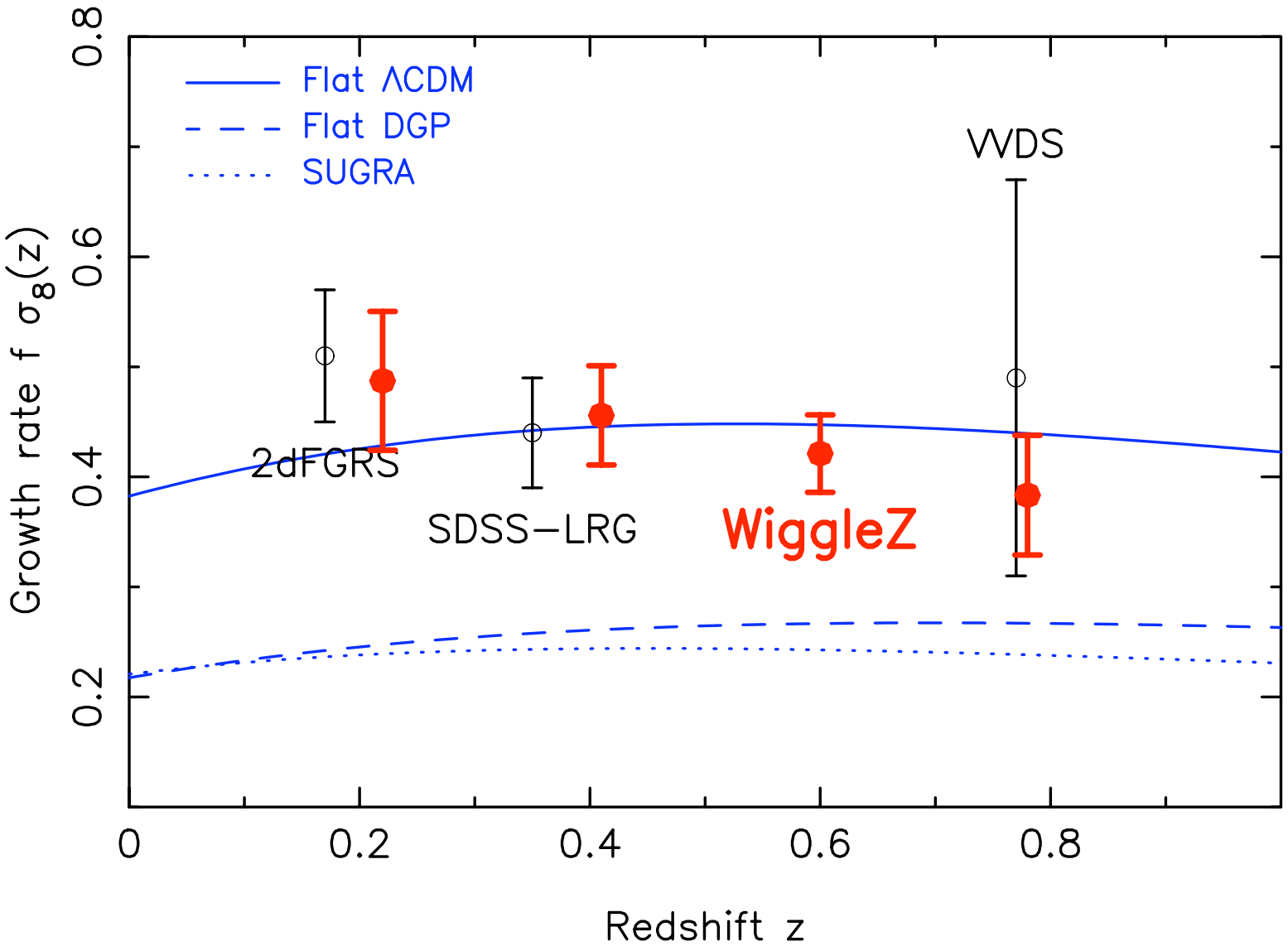
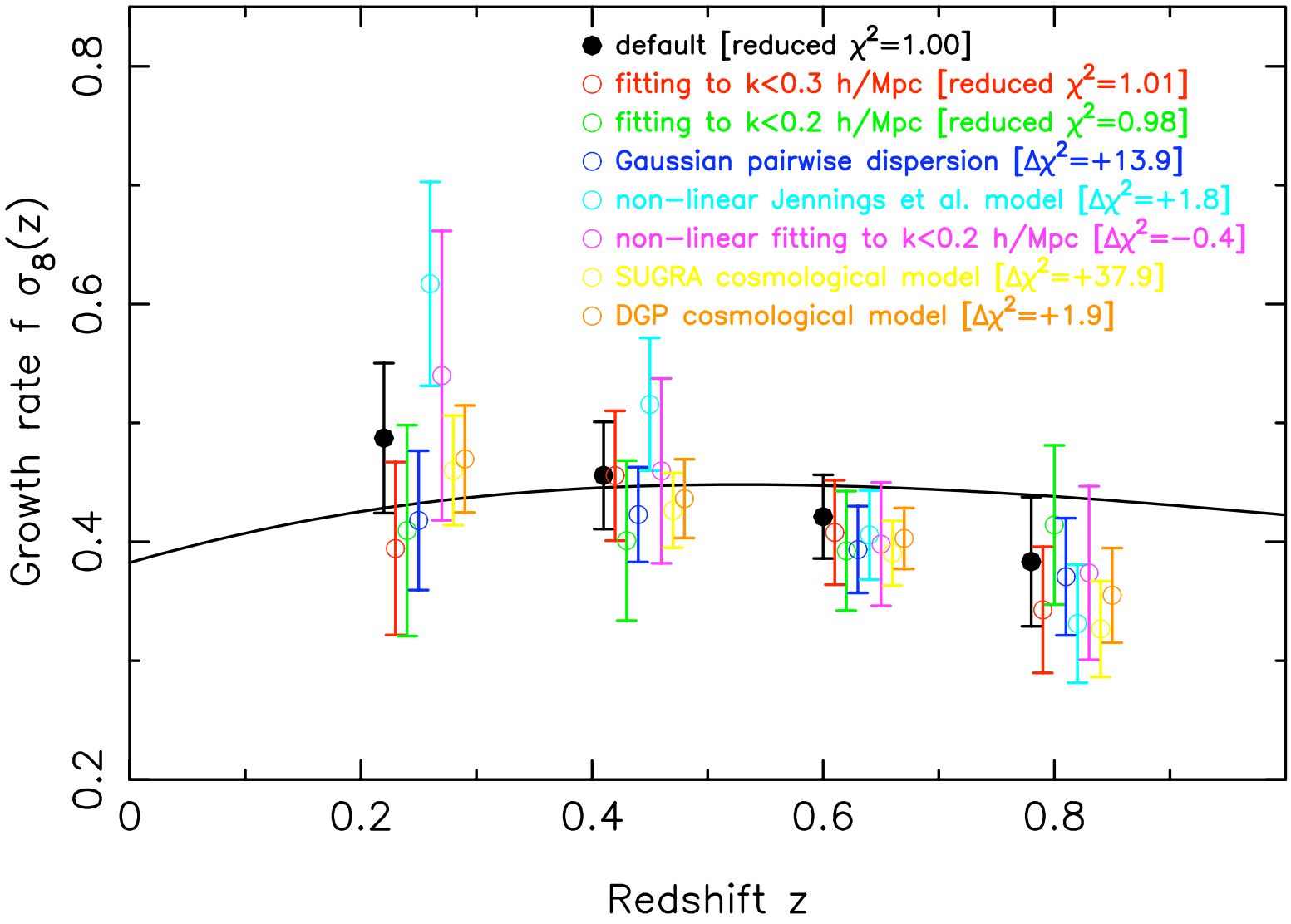


Growth of structure results



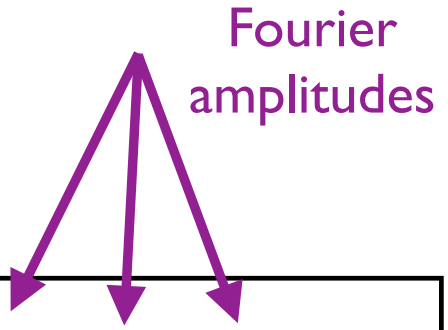
Growth of structure results

$$\boxed{f = \Omega_{\rm m}(z)^{\gamma}}$$

- For a ΛCDM model : $\gamma = 0.60 \pm 0.10$ [prediction 0.55]
- For a DGP model : $\gamma = 0.30 \pm 0.08$ [prediction 0.69]

Bispectrum

- Higher-order clustering statistic - measure of skewness
- Zero for Gaussian fields

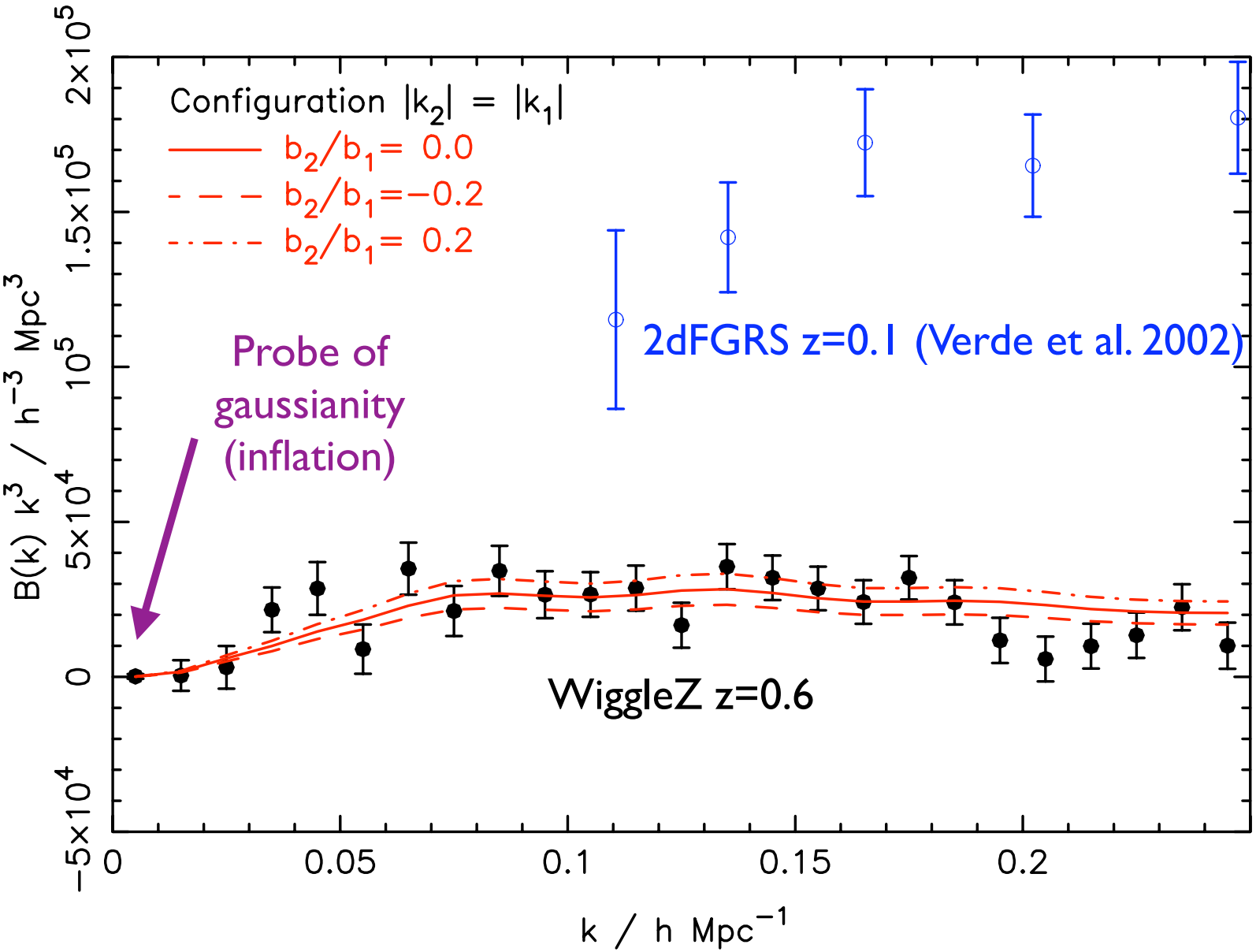


$$B(\vec{k_1}, \vec{k_2}, \vec{k_3}) = < \delta_{\vec{k_1}} \delta_{\vec{k_2}} \delta_{\vec{k_3}} >$$

$$\vec{k_1} + \vec{k_2} + \vec{k_3} = 0$$

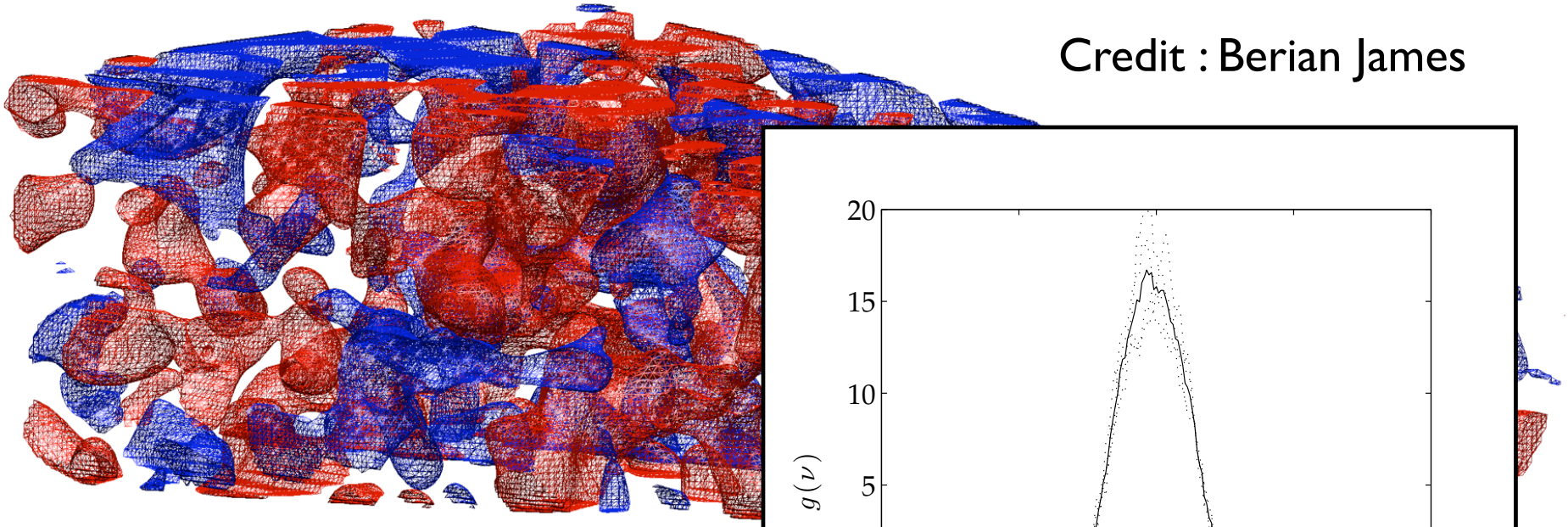
$$\delta_g = b_1 \delta_m + \frac{1}{2} b_2 \delta_m^2$$

Bispectrum


Configuration $|k_2| = |k_1|$
$b_2/b_1 = 0.0$
$b_2/b_1 = -0.2$
$b_2/b_1 = 0.2$
Probe of gaussianity (inflation)
2dFGRS z=0.1 (Verde et al. 2002)
WiggleZ z=0.6
$B(k)\ k^3 / h^{-3}\ Mpc^3$
$k / h\ Mpc^{-1}$
2×10^5
1.5×10^5
10^5
5×10^4
0
-5×10^4
0
0.05
0.1
0.15
0.2

Topology of density field

WiggleZ 15-hr region :



Credit : Berian James

Measurement of the genus curve of the density field smoothed by 20 Mpc/h :