Large scale structure analysis with the 6dF Galaxy Survey
Cosmic Flow: In the rainforest, Queensland

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+ Matthew Colless

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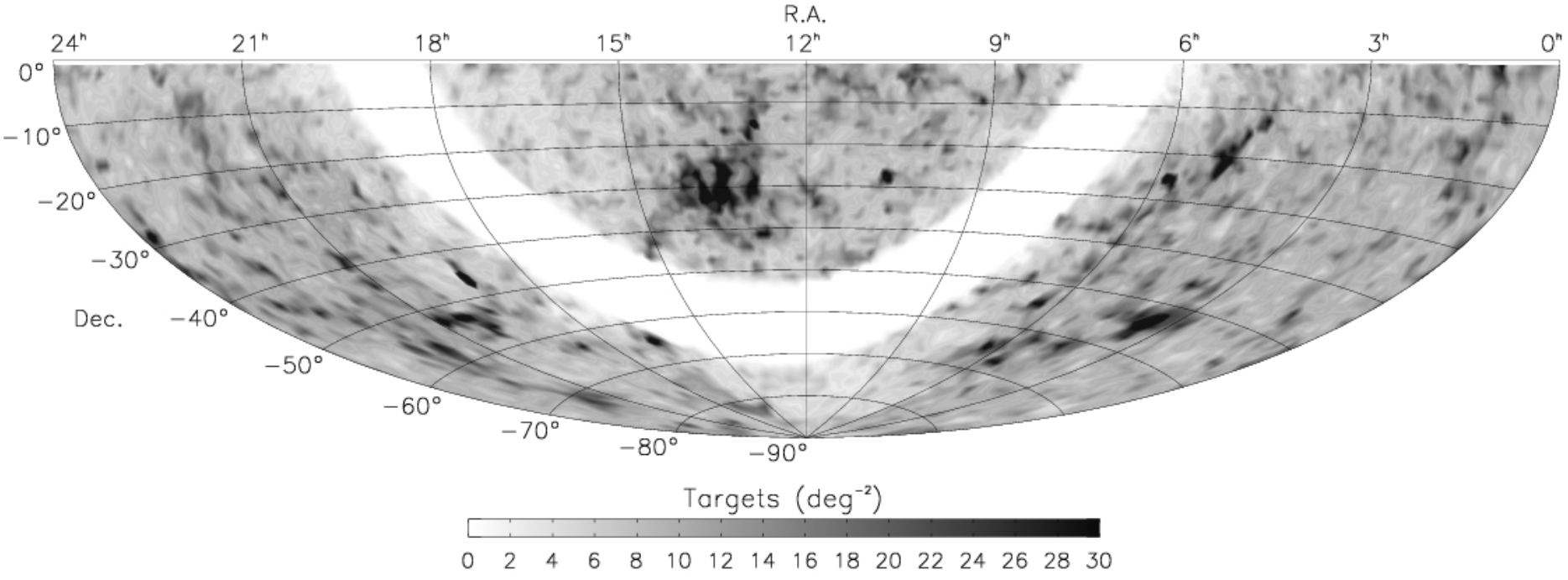
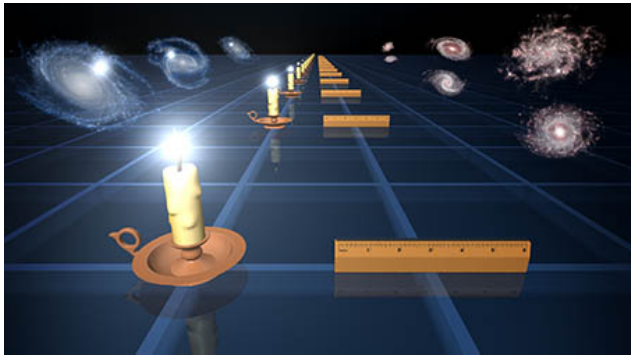
Outline of the talk

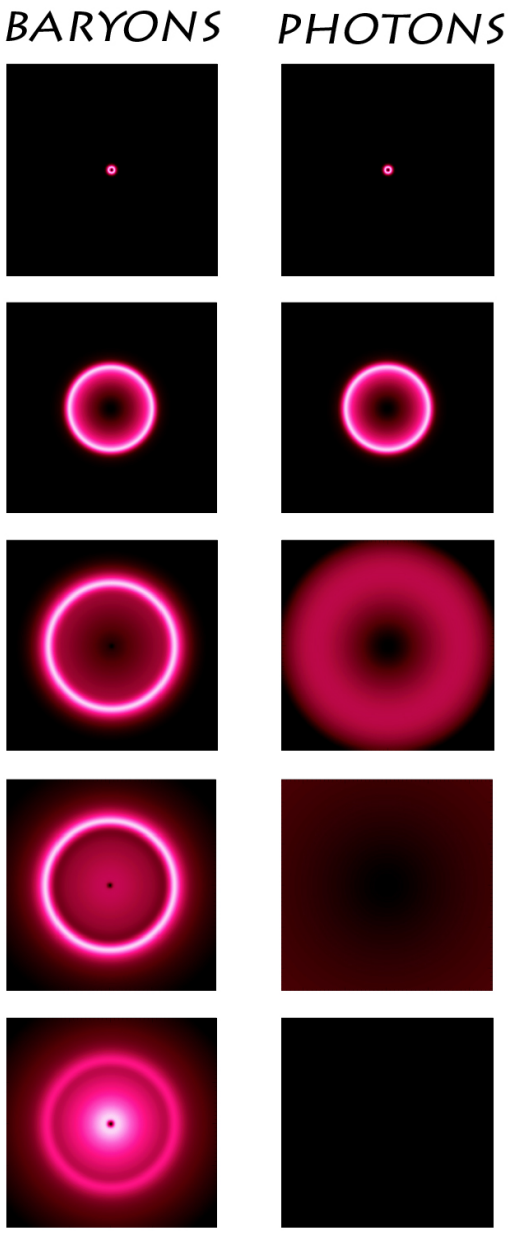
- What is 6dFGS?
- Baryon Acoustic Oscillation (BAO) analysis in 6dFGS.
- Future outlook...
- Redshift space distortion analysis in 6dFGS.

What is 6dFGS?

- Spectroscopic survey of southern sky (17 000 deg^2).
- Primary sample from 2MASS with $K_{tot} < 12.75$; also secondary samples with $H < 13.0$, $J < 13.75$, $r < 15.6$, $b < 16.75$.
- Median redshift 0.05 ($\approx$ 220 Mpc).
- Effective volume $\approx 8x10^7 h^{-3}$ Mpc^3 (about as big as 2dFGRS).
- 125 000 redshifts (137 000 spectra).







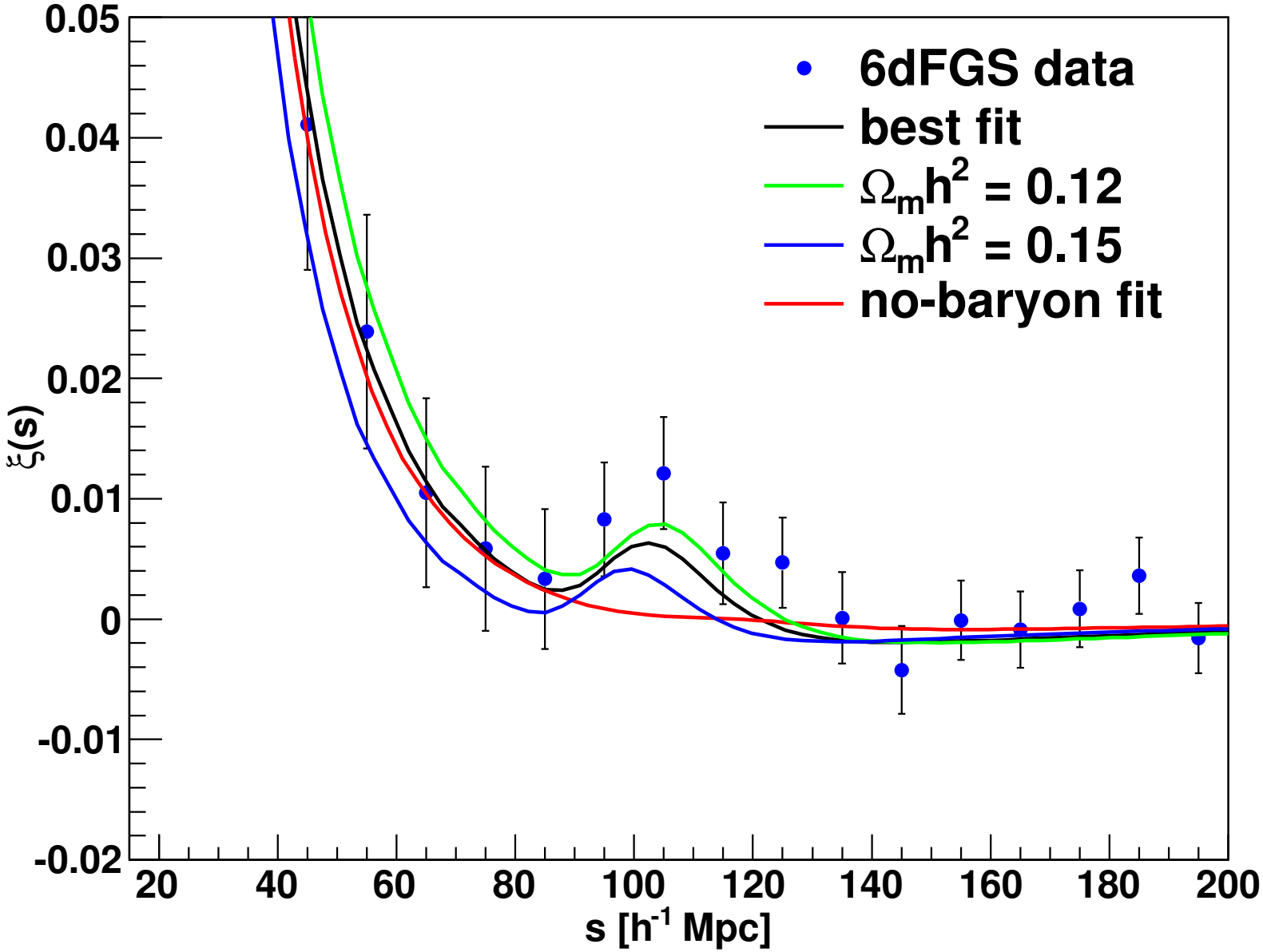
1. The standard ruler size is set by the physical matter- and baryon density, $\Omega_m h^2$ and $\Omega_b h^2$ from the CMB.
2. The apparent size of the standard ruler in the galaxy survey gives a distance measurement.
3. This enables us to measure the Friedmann eq., $H(z)$

$$H(z) = H_0 \left[\Omega_m a^{-3} + \Omega_\Lambda a^{-3(1+w)}\right]^{1/2}.$$

4. At low redshift, $a \approx 1$, a distance measurement constrains only H_0 (similar to the distance ladder technique).

Martin White

Results


0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
ξ(s)
20
40
60
80
100
120
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s [h^-1 Mpc]
6dFGS data
best fit
Ωmh2 = 0.12
Ωmh2 = 0.15
no-baryon fit

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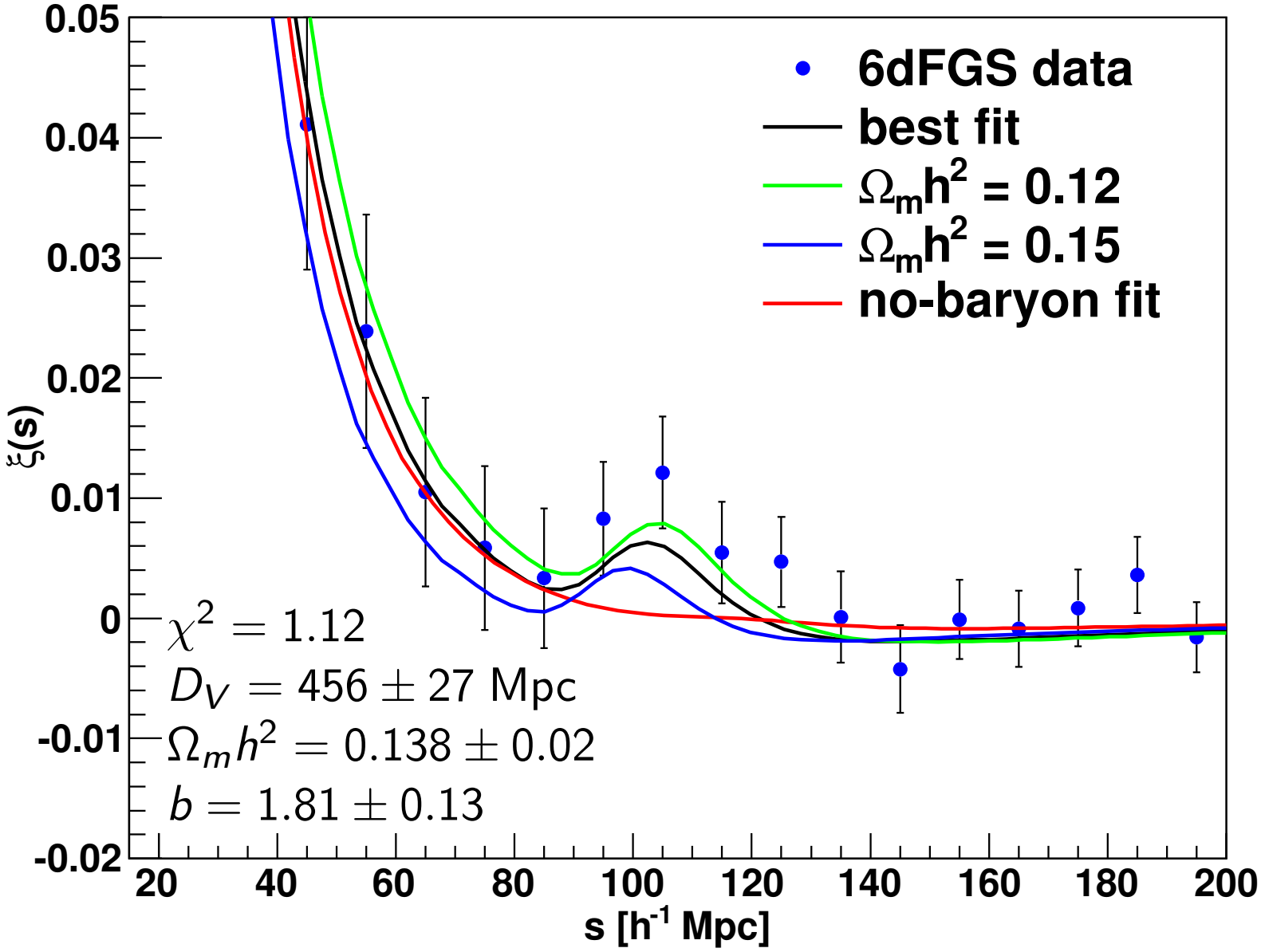
6dFGS data
best fit
$\Omega_m h^2 = 0.12$
$\Omega_m h^2 = 0.15$
no-baryon fit
$\chi^2 = 1.12$
$D_V = 456 \pm 27$ Mpc
$\Omega_m h^2 = 0.138 \pm 0.02$
$b = 1.81 \pm 0.13$
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s [h^{-1} Mpc]
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0.03
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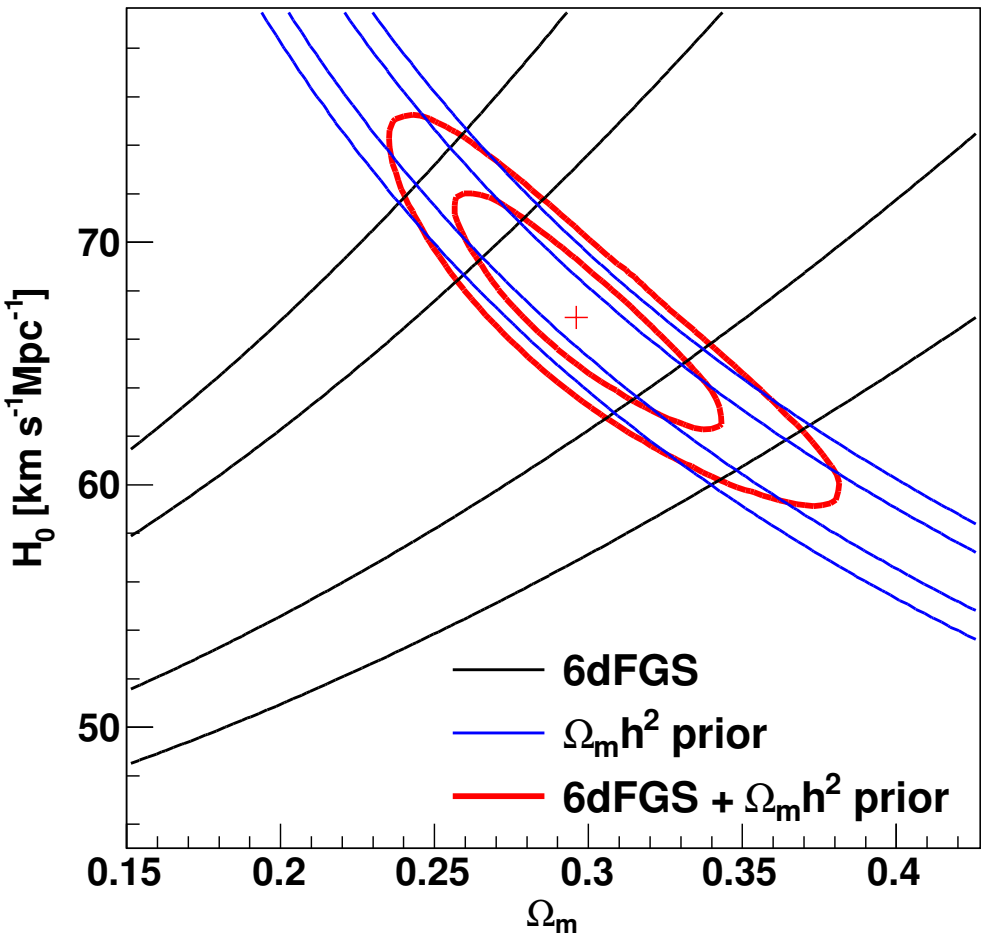
Cosmological implications



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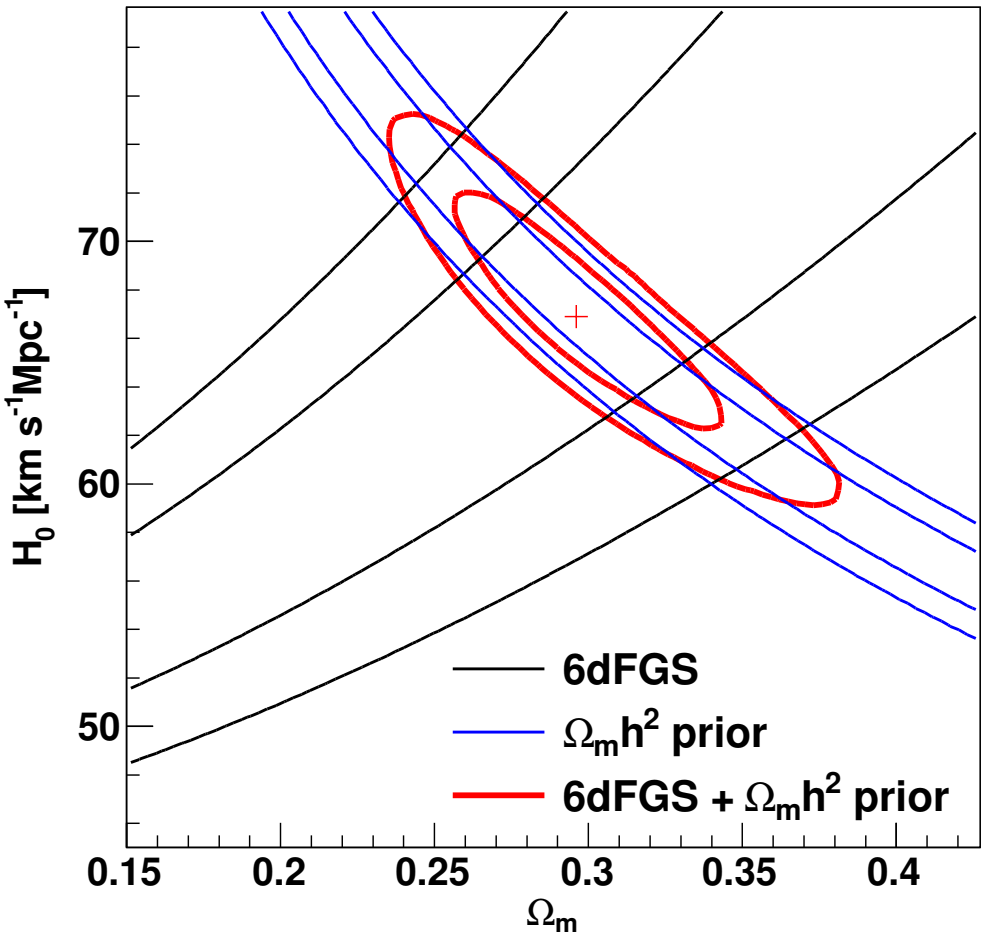

6dFGS: $H_0 = 67 \pm 3.2\,\mathrm{km/s/Mpc}$

SH0ES project: $H_0 = 73.8 \pm 2.4\,\mathrm{km/s/Mpc}$ (Riess et al. 2011)

WMAP7: $H_0 = 70.3 \pm 2.5\,\mathrm{km/s/Mpc}$ (Komatsu et al. 2010)

Cosmological implications

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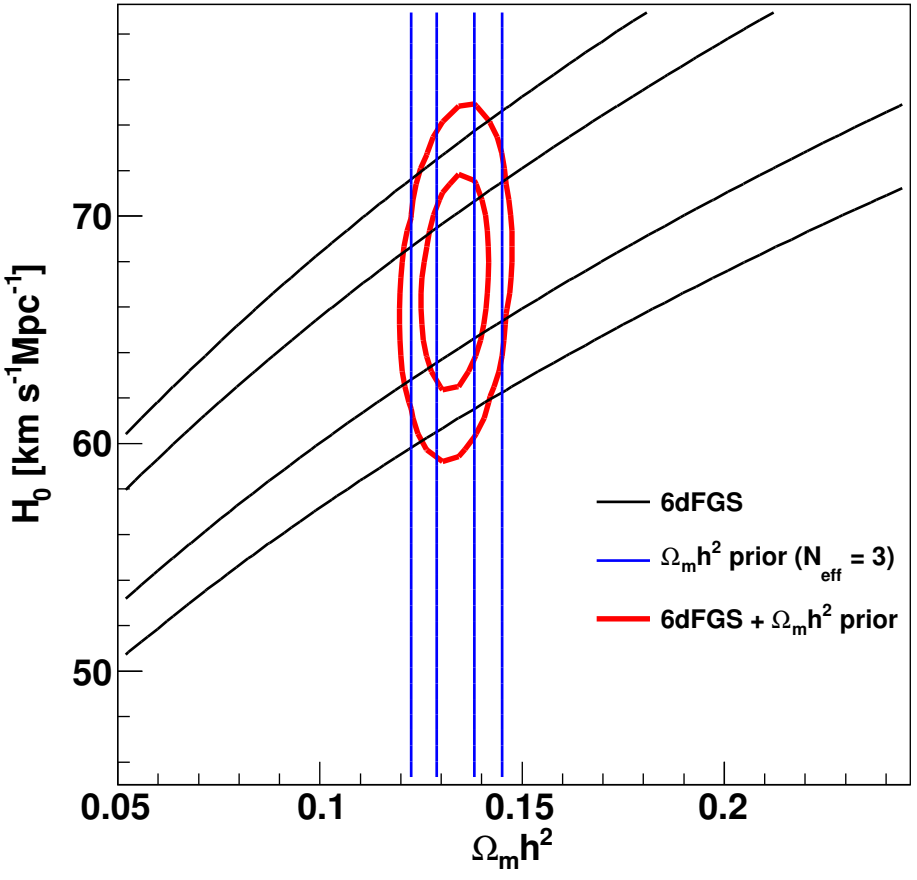

$$N_{\mathrm{eff}} = 3.04 + 7.44 \left(\frac{\Omega_m h^2}{0.1308} \frac{3139}{1+z_{\mathrm{eq}}} - 1 \right)$$

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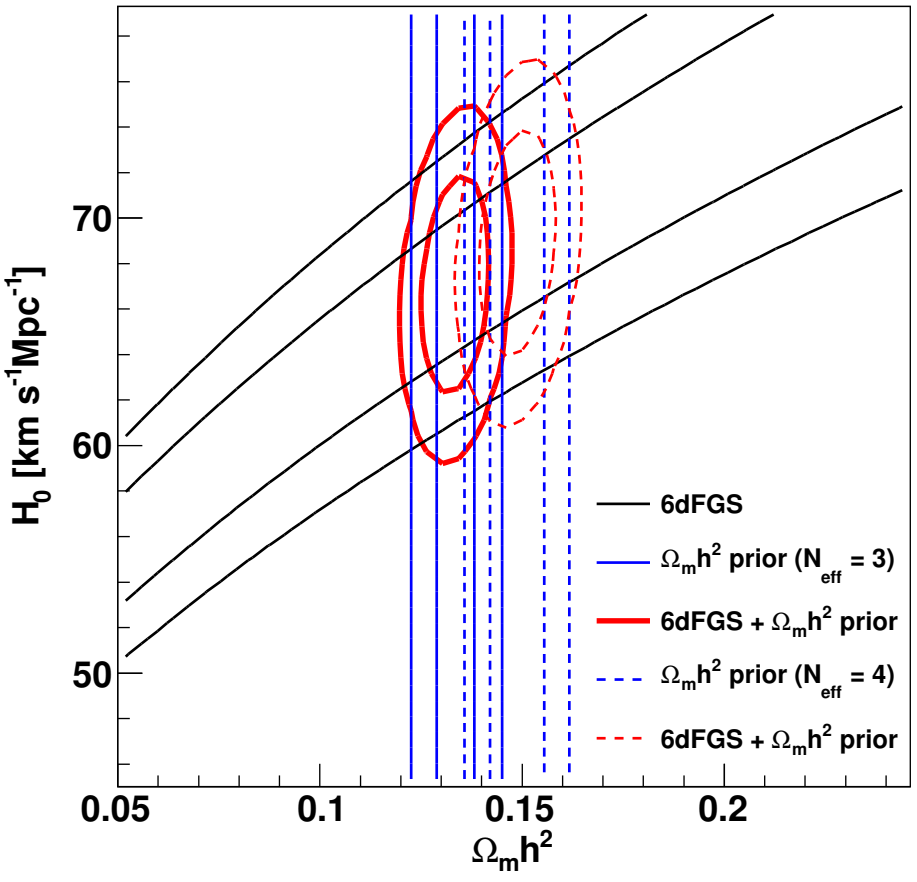

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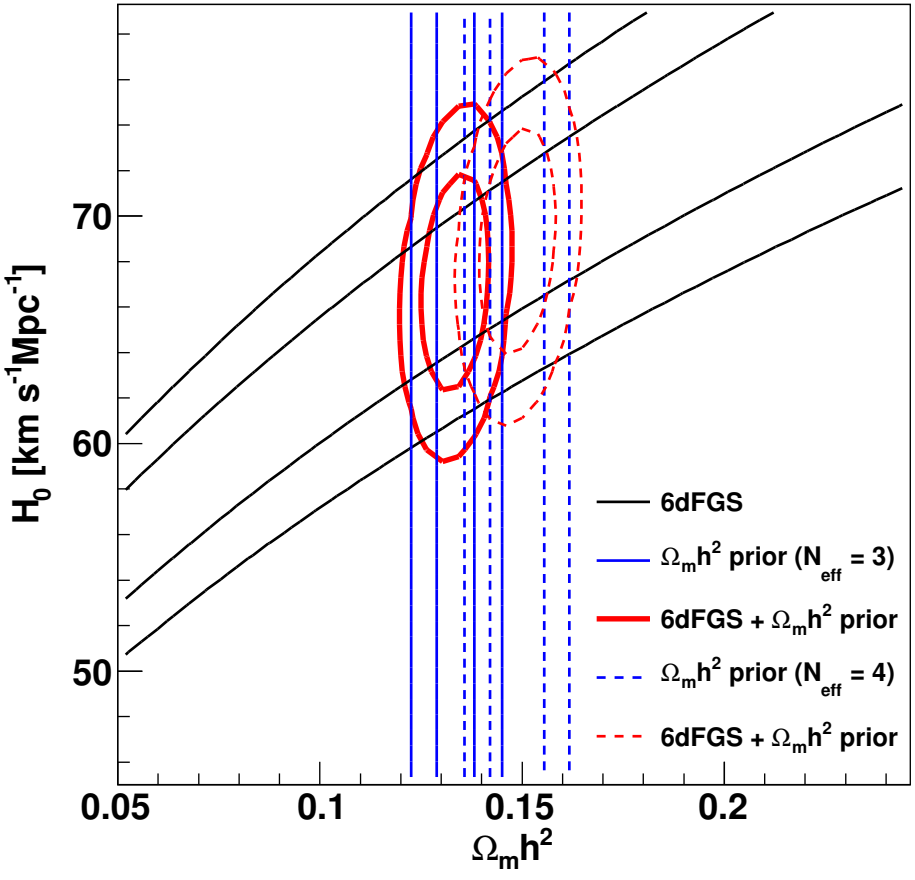
If $N_{\mathrm{eff}} > 3$ the BAO measurement of H_0 is biased low.



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Future outlook

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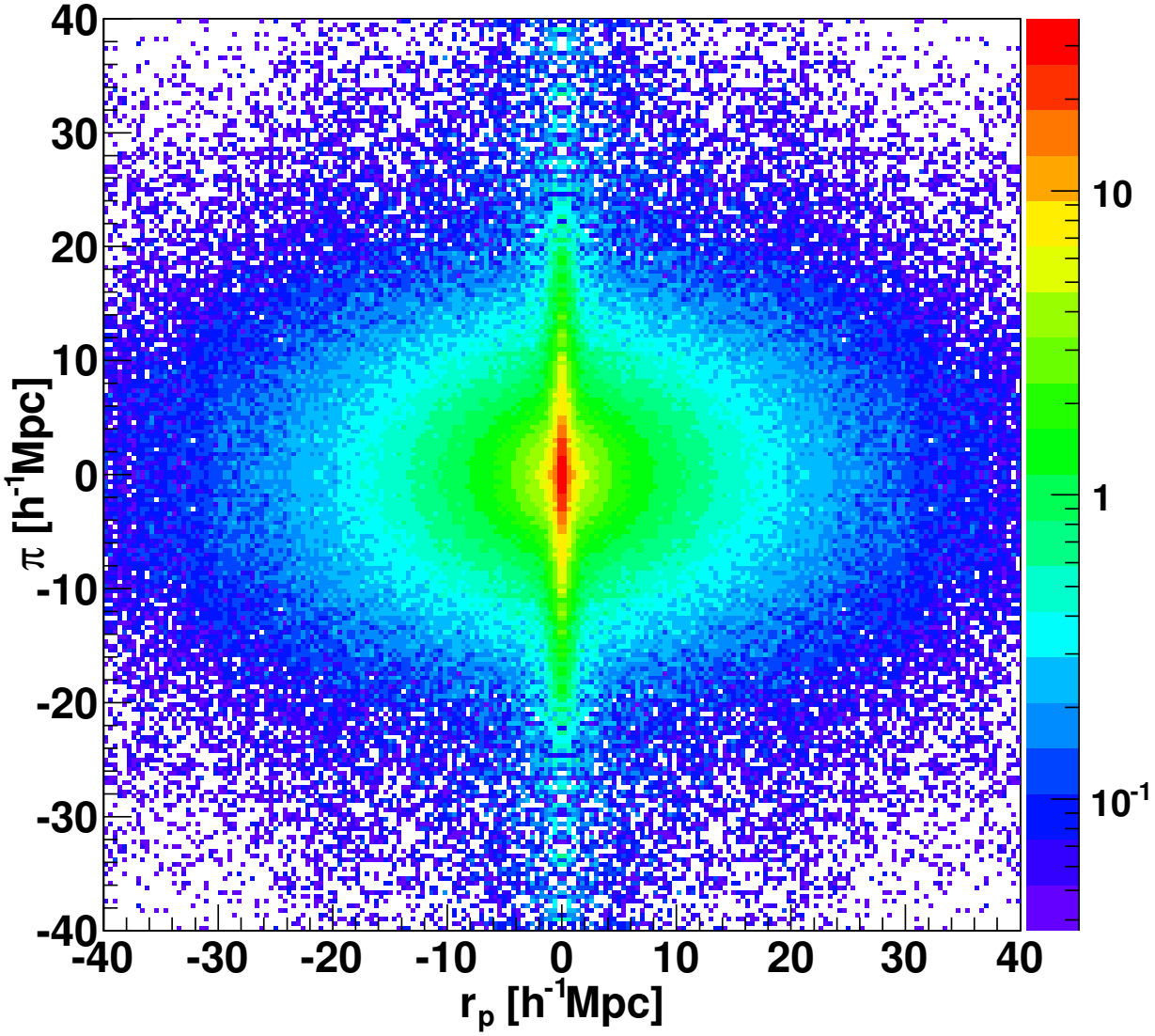
- Increasing the survey volume at low redshift (WALLABY and TAIPAN, see Beutler et al. 2011) -> Heath Jones's talk

Redshift space distortion analysis

6dFGS 2D correlation function



What would be the best redshift space distortion survey?

- The error of the power spectrum is prop. to its amplitude

$$\sigma_{P(k)} \propto (b + f\mu^2)^2 P(k) + < N >$$

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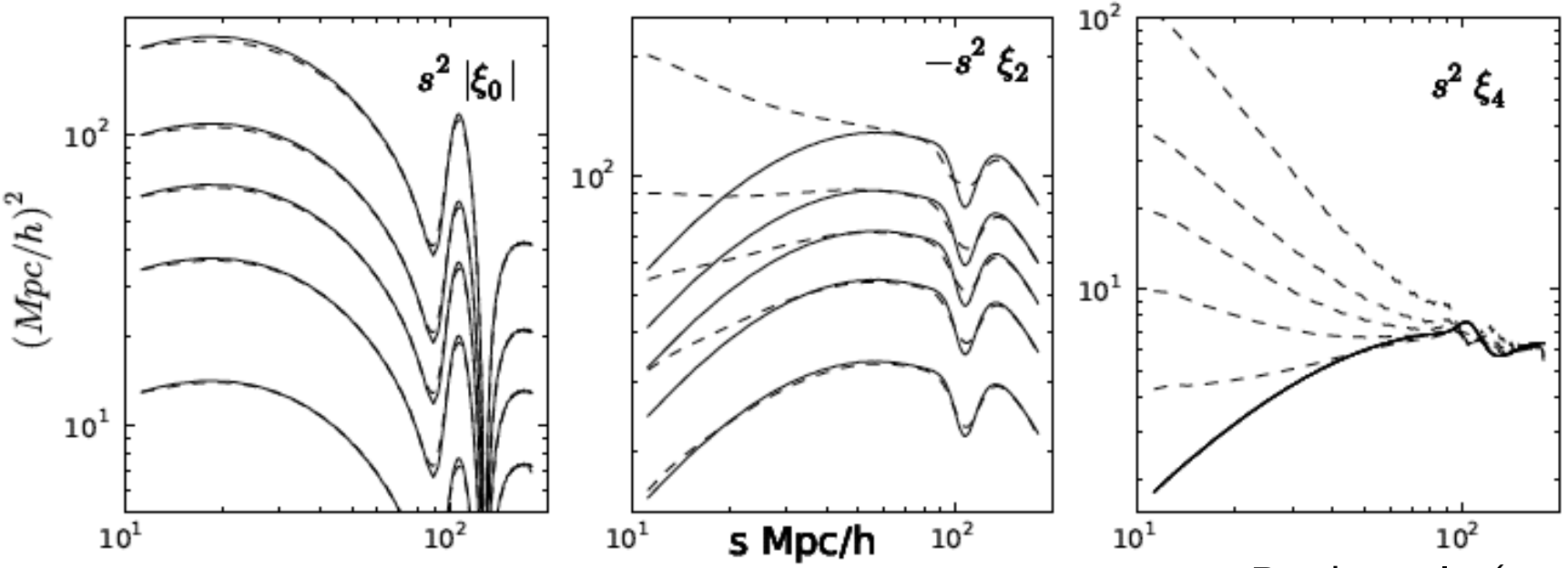
  $\rightarrow$ Simpson et al. (2011)
-

Non-linear effects and galaxy bias



Reid et al. (2011)

Correlation function moments:

$$\xi_\ell(r) = \int \xi(r_p, \pi)\mathcal{P}_\ell(\mu)d\mu,$$

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- Small scales have high statistics, but often can not be used because of non-linear effects which are difficult to model. Avoiding high density regions of the density field reduces non-linear contributions
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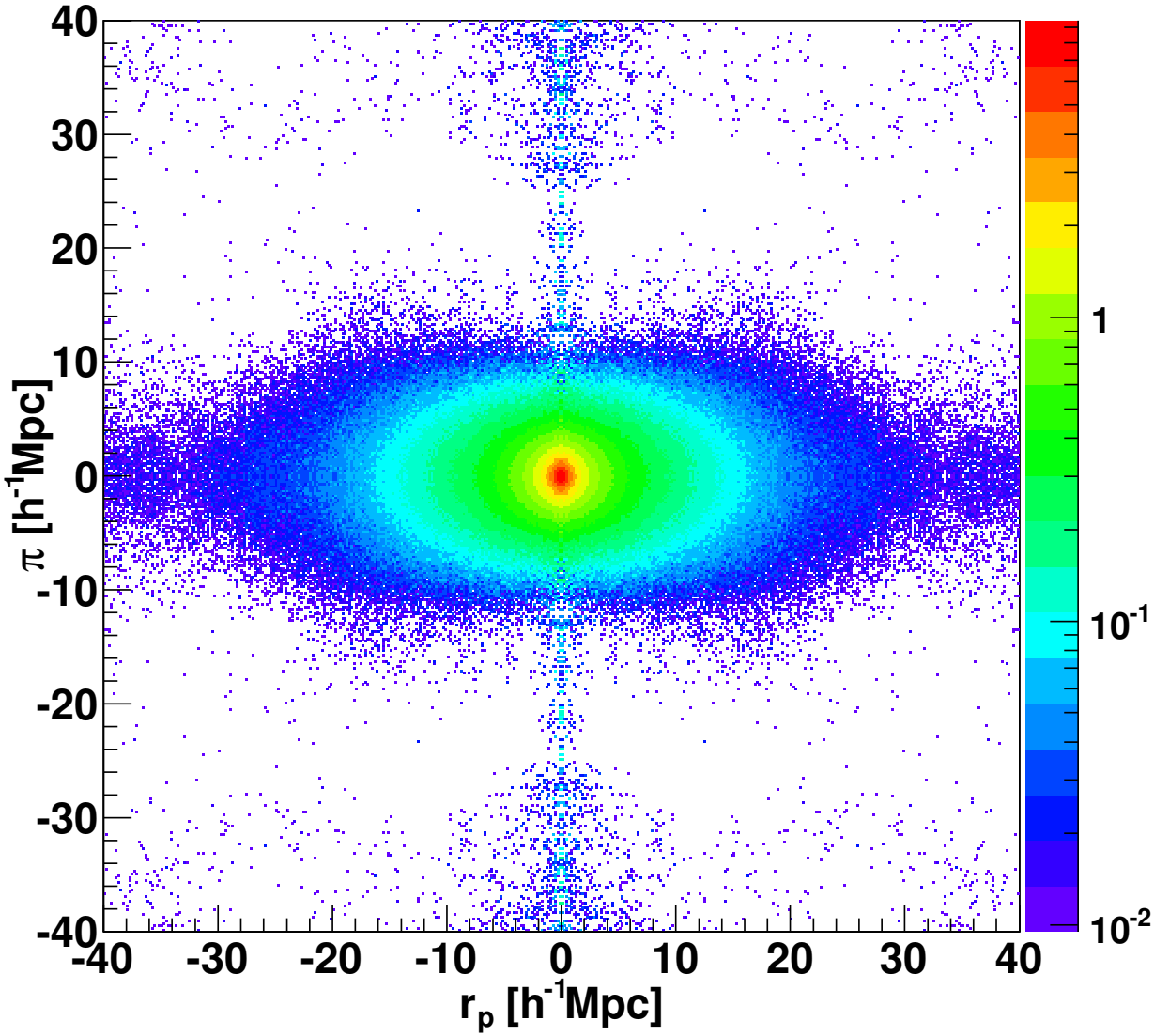
- At low redshift we don't have to deal with the degeneracy between the Alcock-Paczynski effect and redshift space distortions.

The WALLABY galaxy survey

- Radio galaxy survey conducted on the ASKAP radio telescope, a precursor of the Square Kilometre Array (SKA). The telescope is located in the West Australian desert. -> Lister's talk
- Timeline: 2014-2018
- $\sim 600\,000$ galaxies
- $V_{\mathrm{eff}} \approx 0.12 h^{-3}\,\mathrm{Gpc}^3$
- galaxy bias ~ 0.7 (Basilakos et al. 2007)
- $z \approx 0.04$

WALLABY forecast



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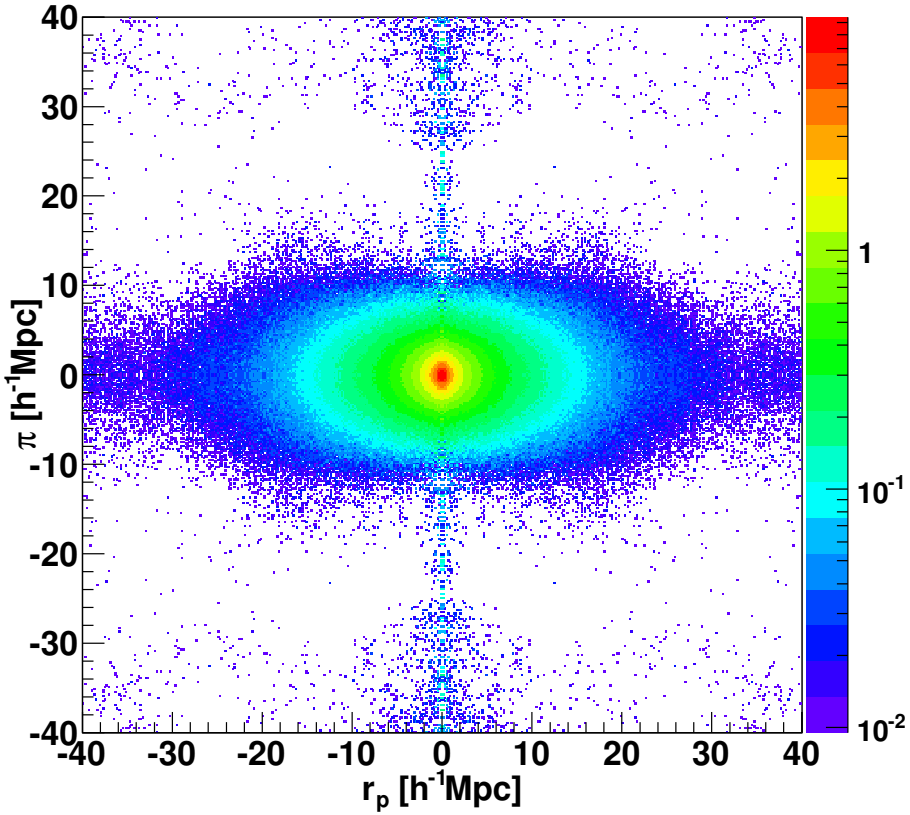
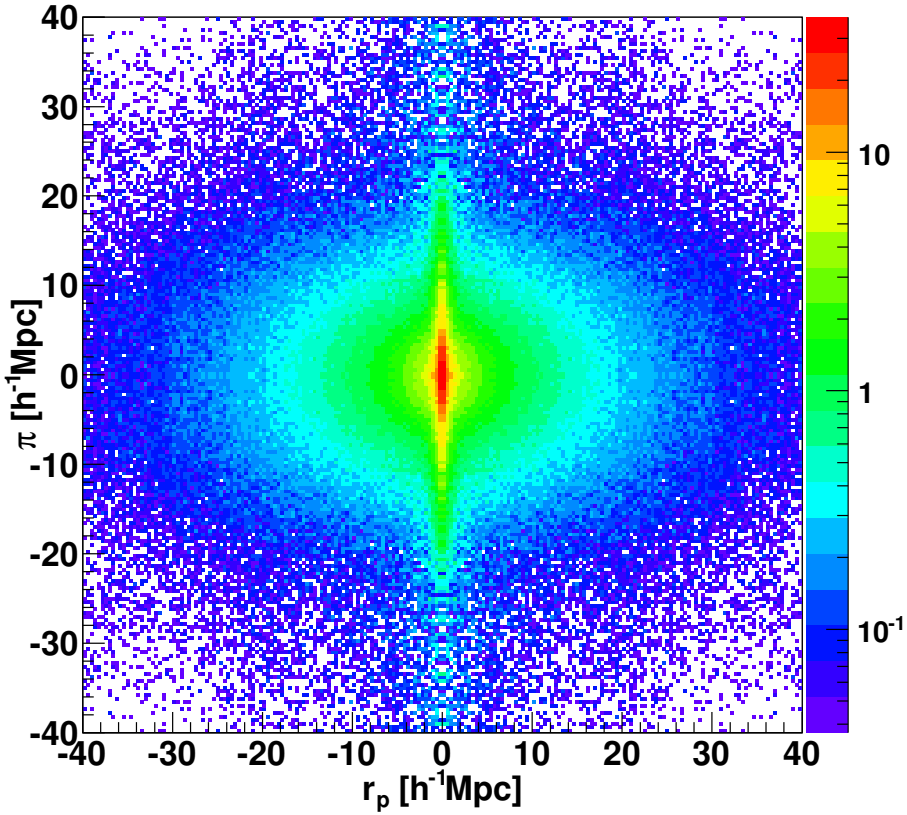
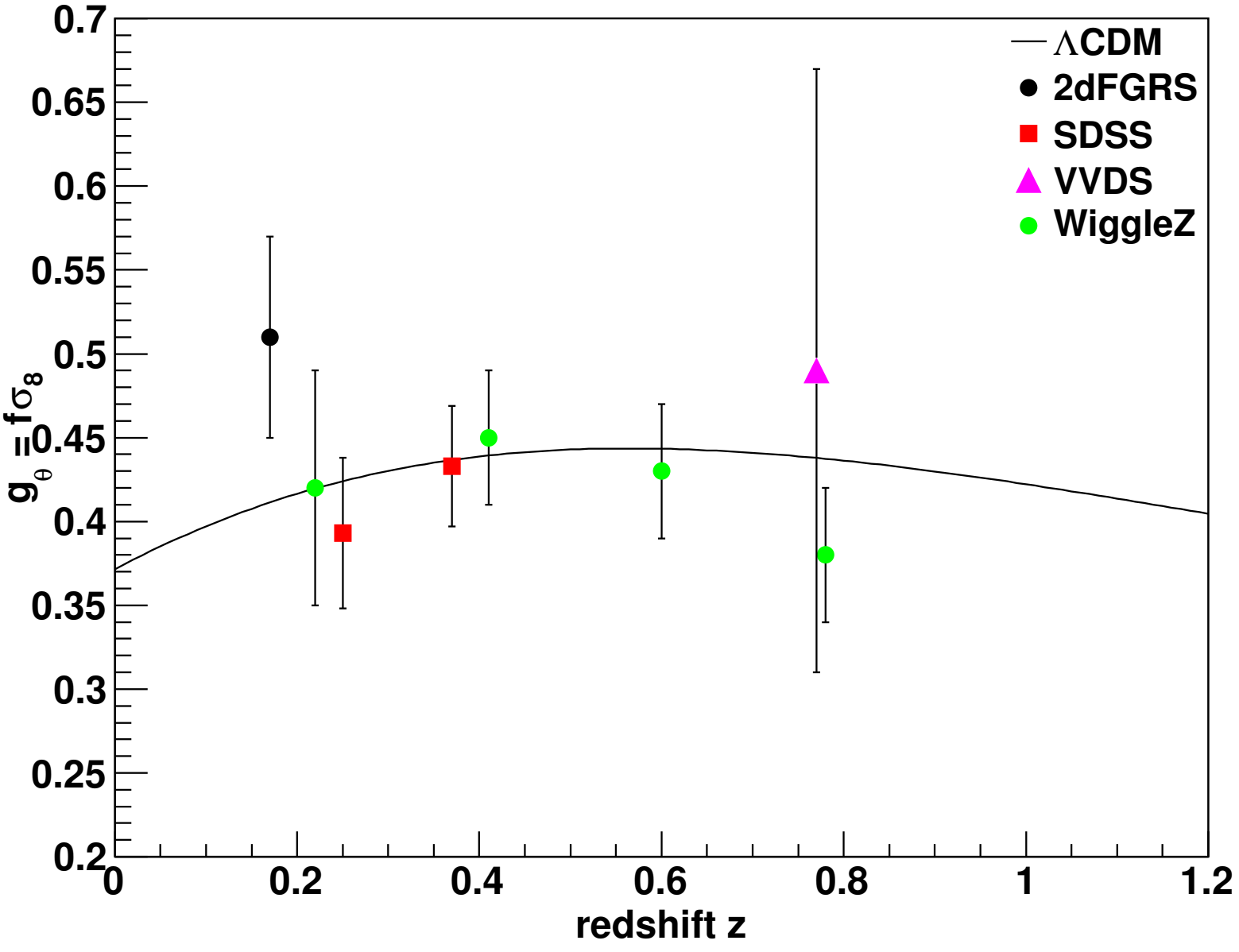




Future survey forecasts



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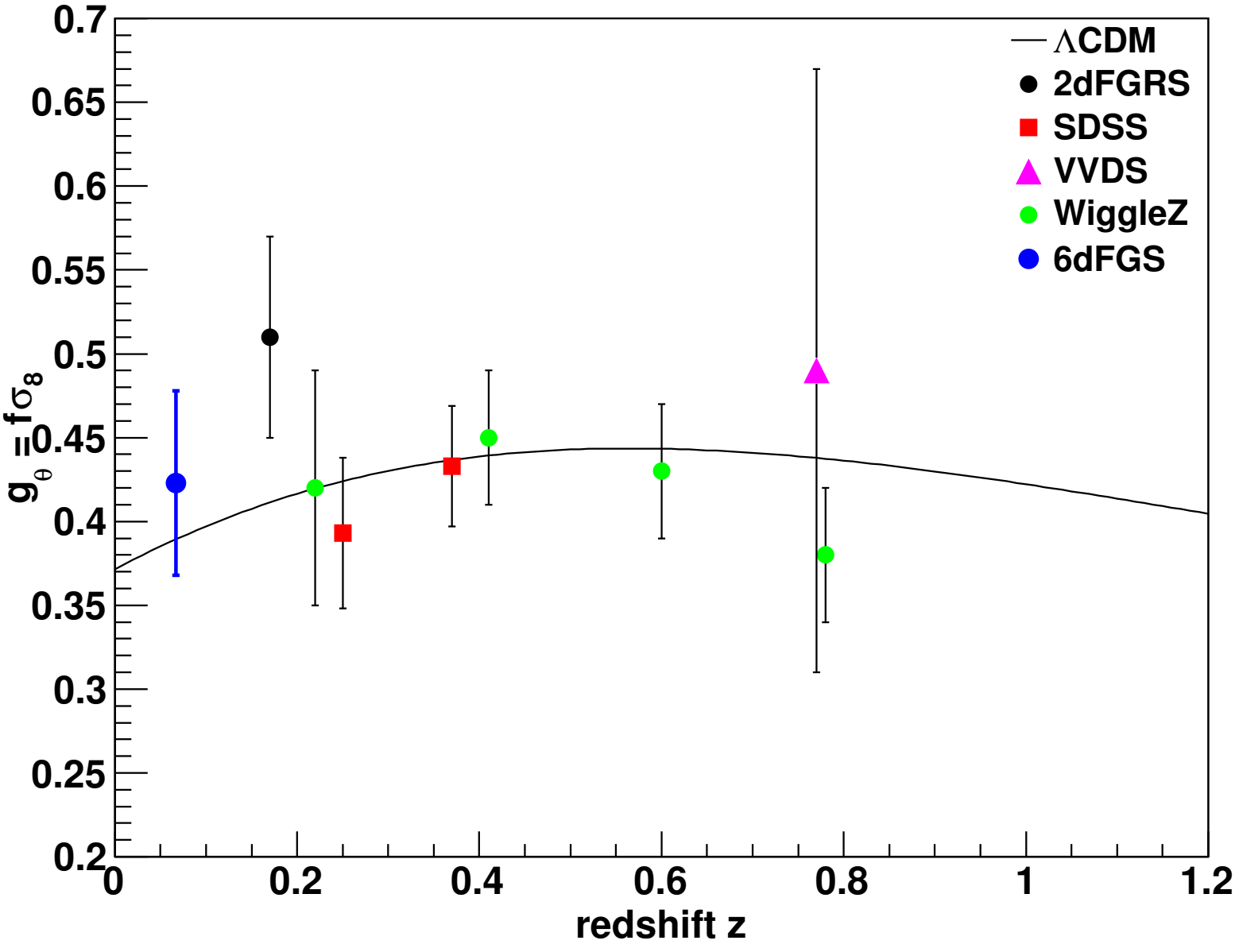

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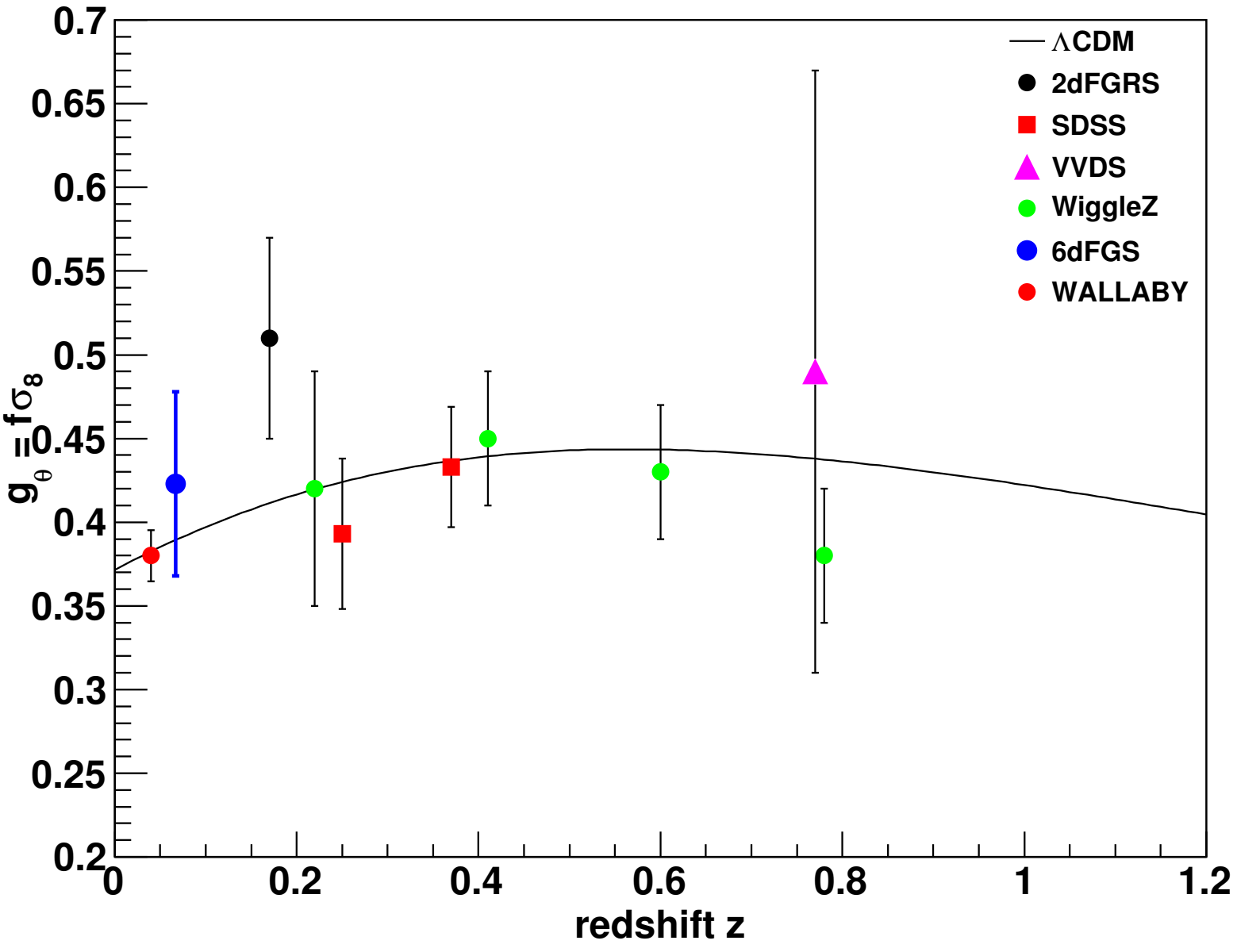
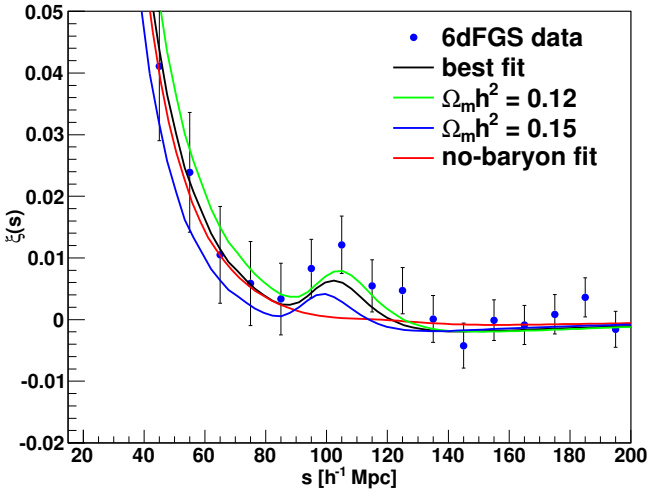


Conclusion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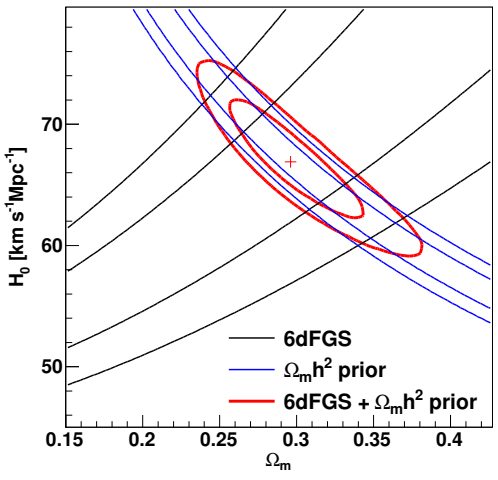
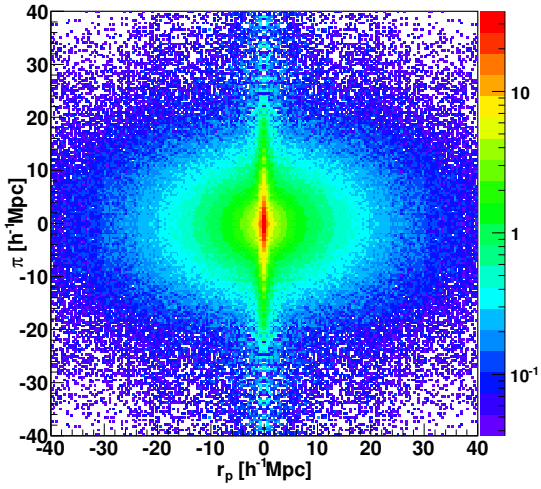
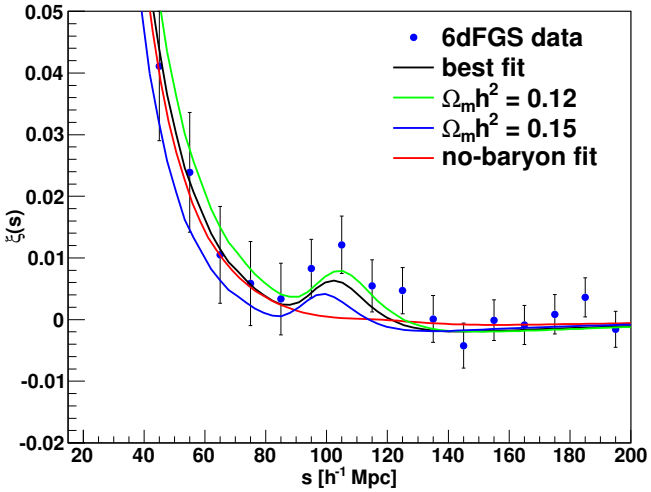
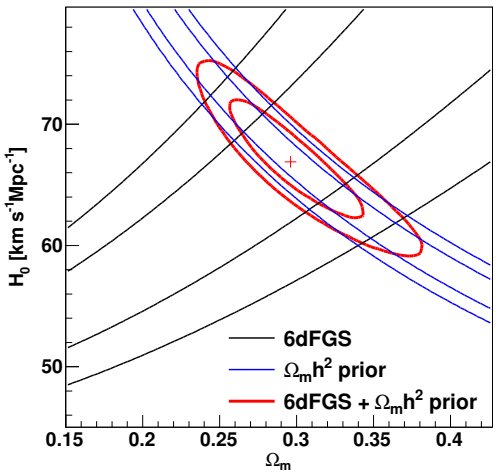
$\xi(s)$
s [h^{-1} Mpc]

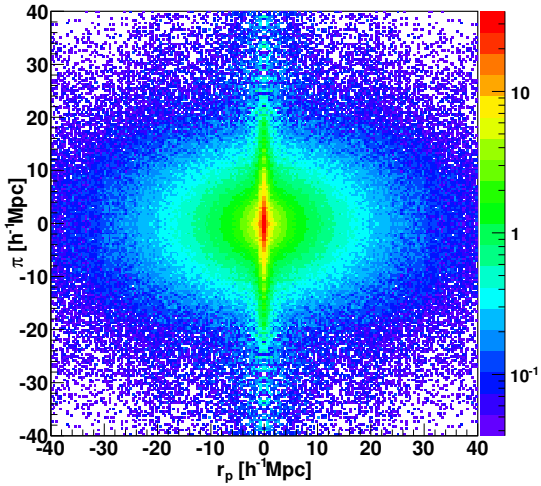

6dFGS
$\Omega_m h^2$ prior
6dFGS + $\Omega_m h^2$ prior
H_0 [km s^{-1}Mpc^{-1}]
Ω_m


π [h^{-1}Mpc]
r_p [h^{-1}Mpc]

Conclusion







- The low redshift BAO detection in 6dFGS allows a measurement of the Hubble Constant of

$$H_0 = 67 \pm 3.4\,\mathrm{kms}^{-1}\mathrm{Mpc}^{-1}$$

- Radio galaxy surveys have a very low galaxy bias and hence are perfect for RSD analysis.
- WALLABY will be able to measure $f\sigma_8$ to within 3-4% and hence will improve upon the 6dFGS measurement by a factor of 3-4.

Thank you very much