The galaxy power spectrum: 2dFGRS – SDSS tension?

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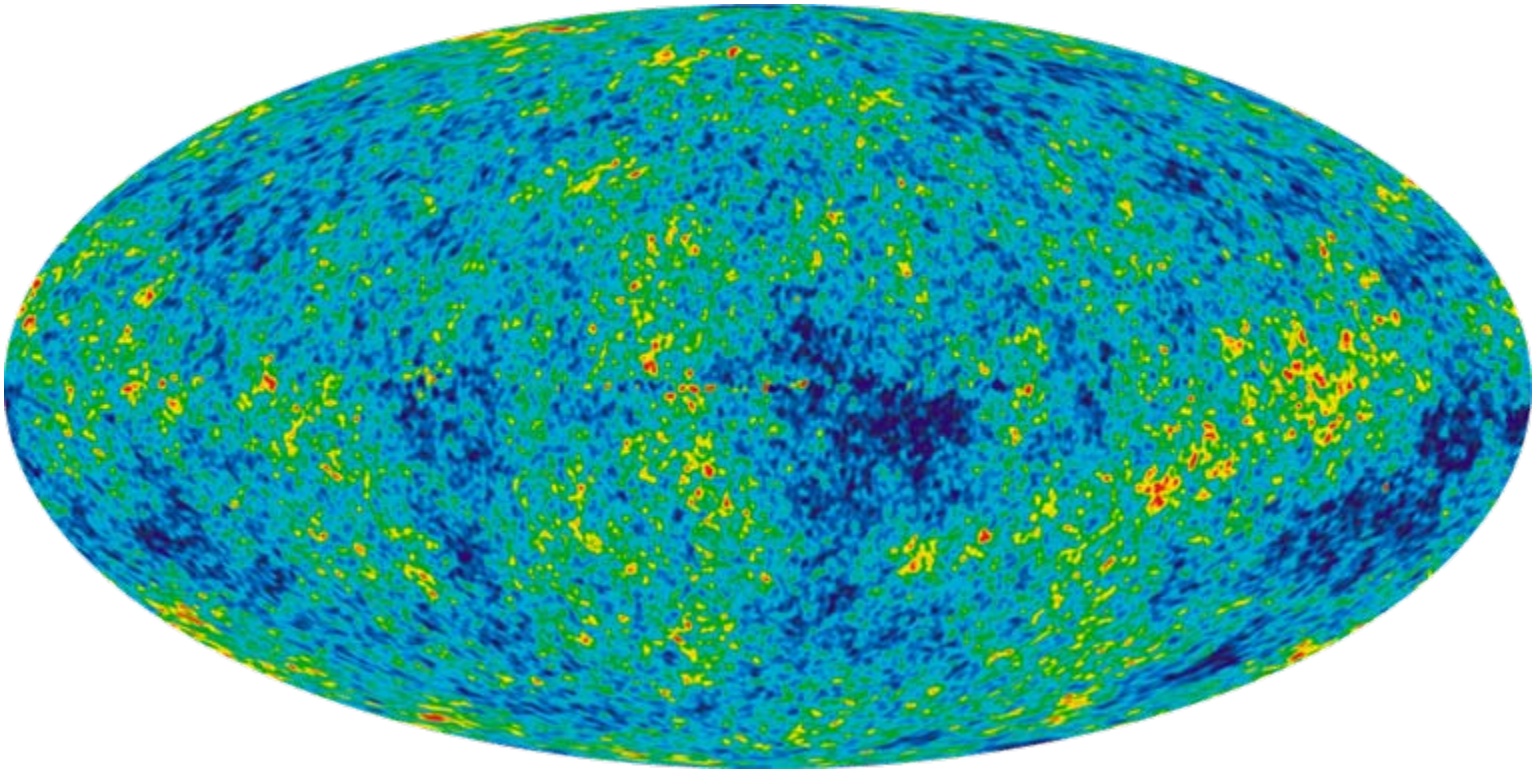
(arXiv:0708.1517)

11th Paris Cosmology Colloquium
August 17, 2007

A data-rich era in cosmology

- Dramatic improvement of Cosmological observations.
- Basic cosmological parameters constrained to ~10%.



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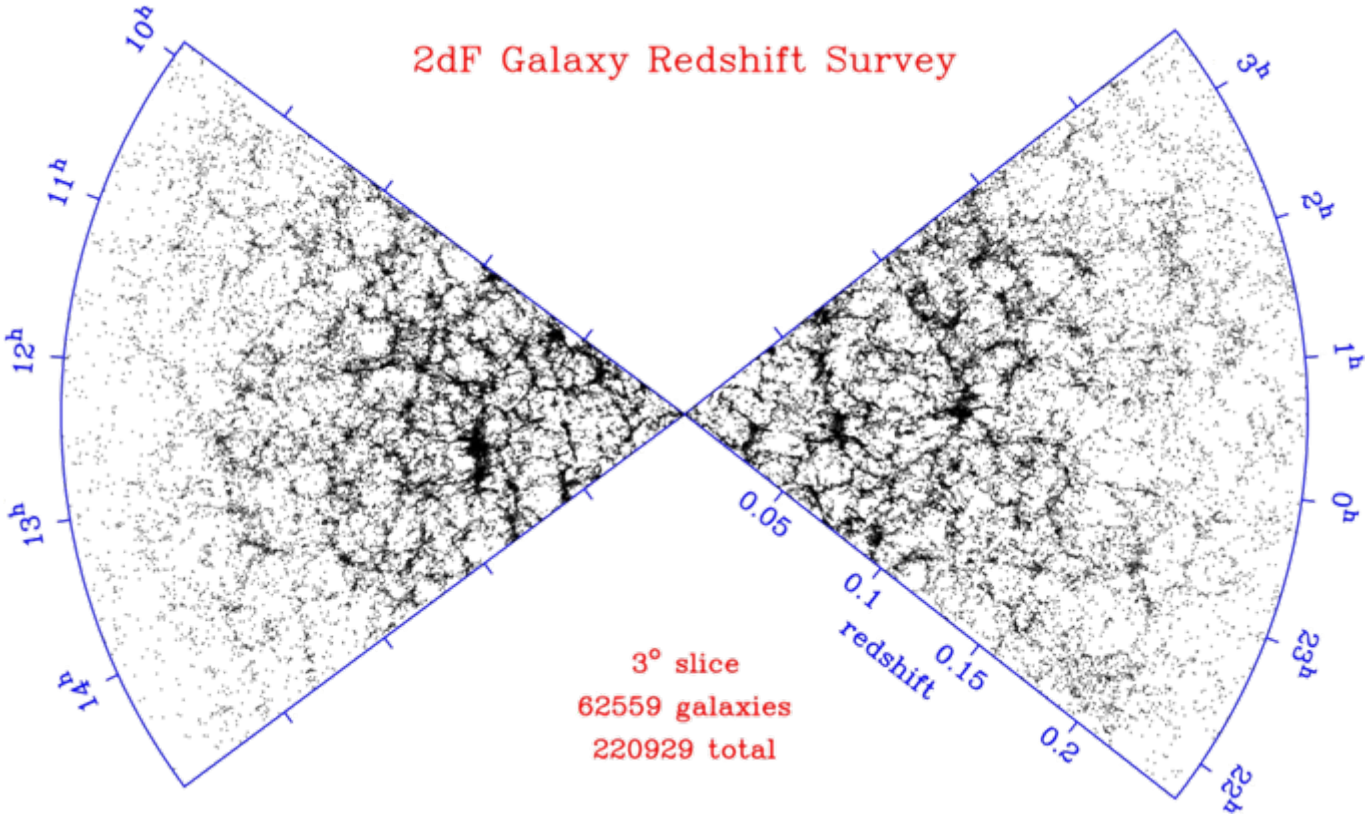
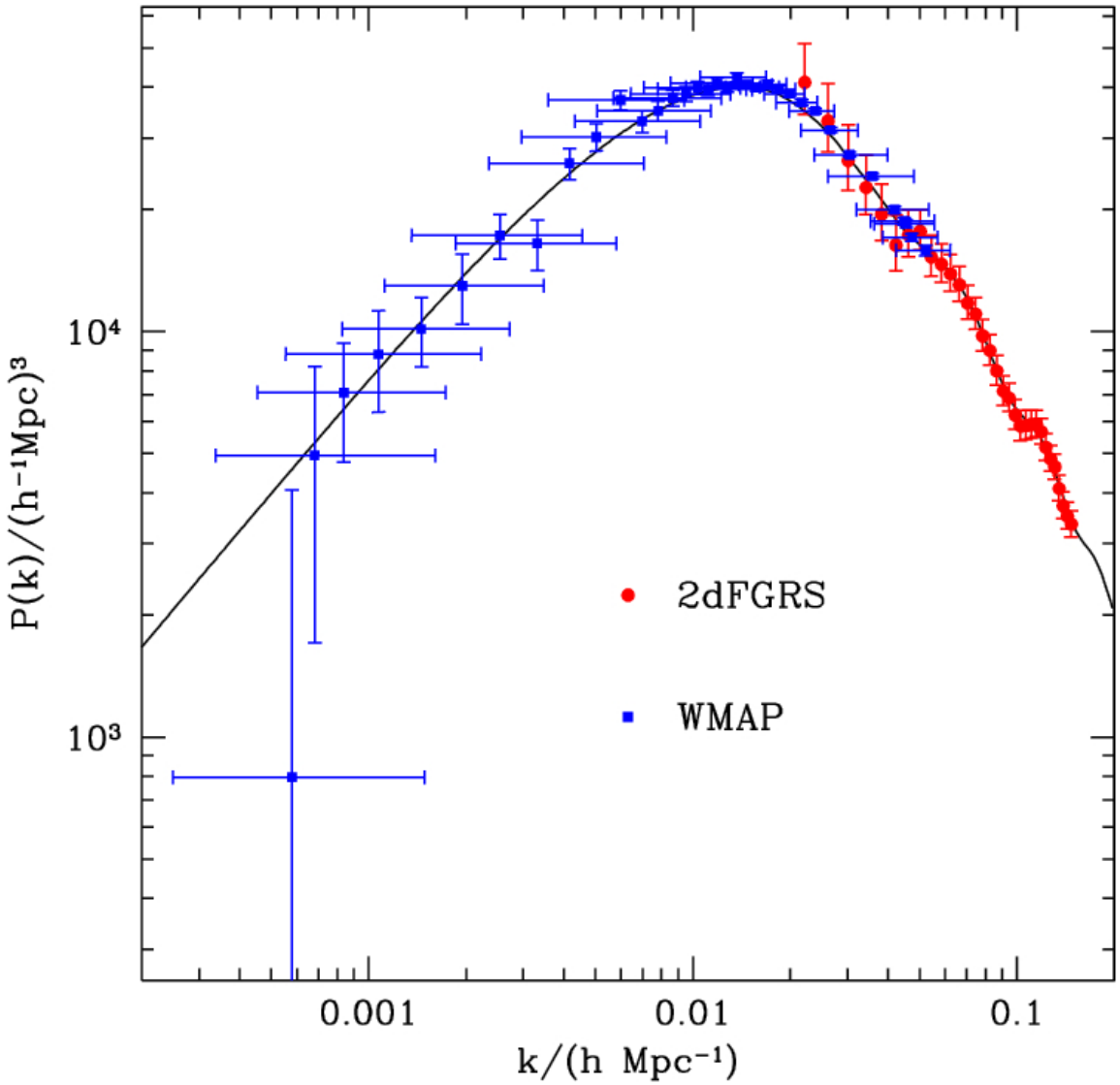


CMB & LSS

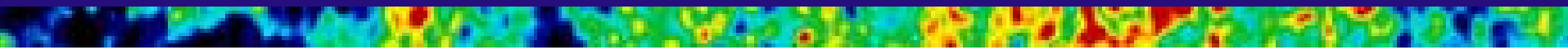
The matter power spectrum is also important for:

- The matter density Ω_{m}
- The scalar spectral index n_{s}
- The mass fraction of massive neutrinos f_{ν}
- Non-flat models Ω_{k}
- The dark energy equation of state w_{DE}

CMB & LSS



2dFGRS – SDSS tension

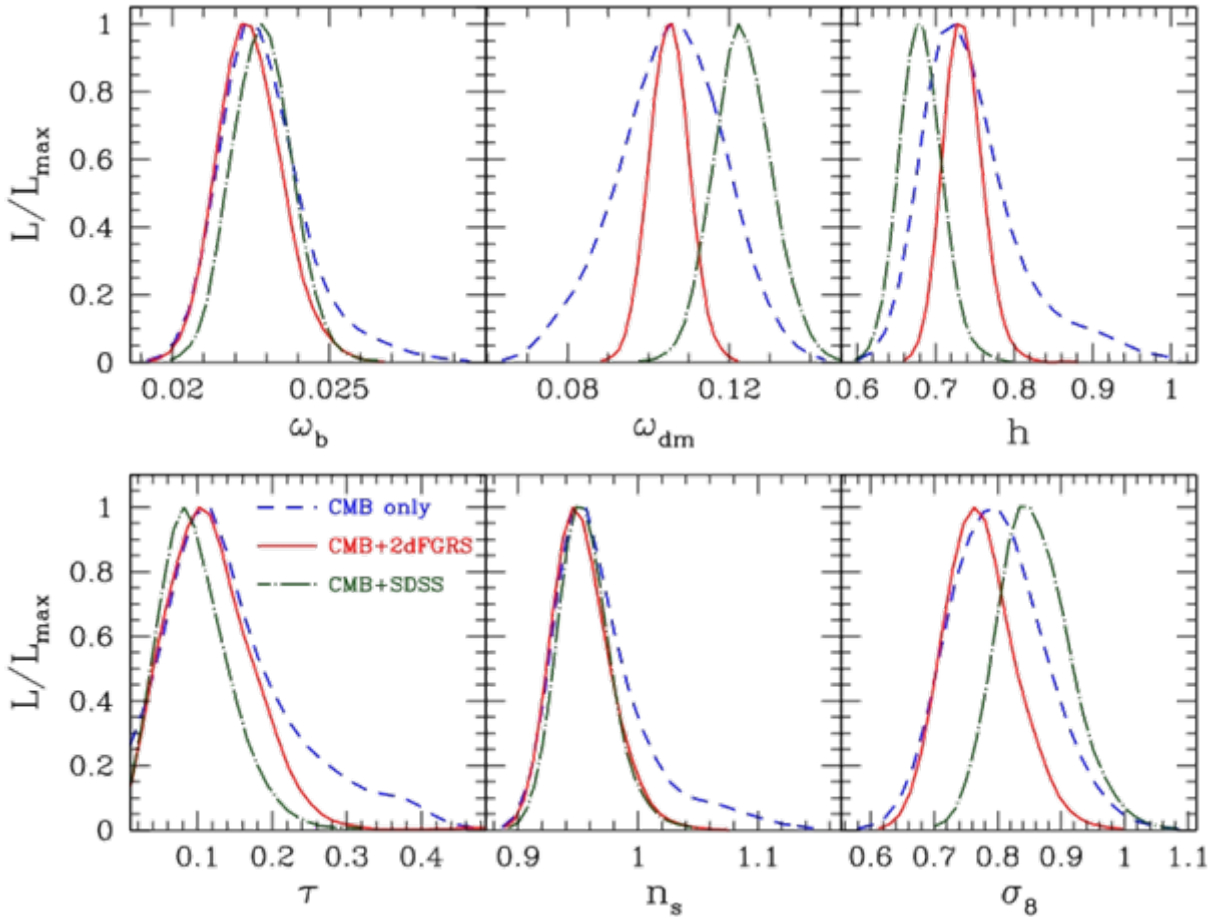


• Rapid improvements in the amount and quality of observations.

• Control of systematic effects in the analysis is Increasingly important.

• How robust the constraints are with respect to the hypothesis implemented?

2dFGRS – SDSS tension



CMB: $\Omega_m = 0.237 \pm 0.055$

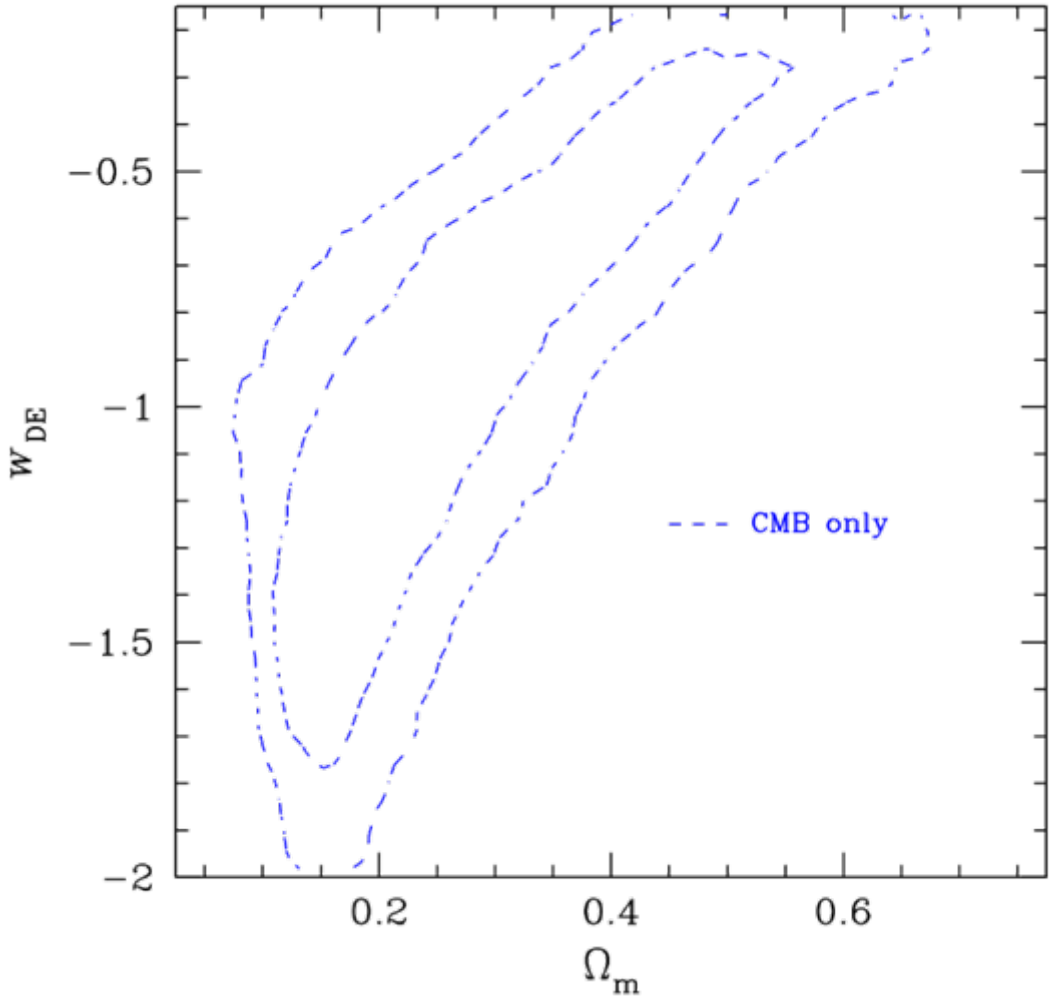
CMB+2dFGRS: $\Omega_m = 0.237 \pm 0.020$

CMB+SDSS: $\Omega_m = 0.317 \pm 0.035$

Sánchez et al. 2006

2dFGRS – SDSS tension

- This has implications for other parameters.



$$w_{DE} = -0.93^{+0.49}_{-0.47}$$

Sánchez et al. 2006

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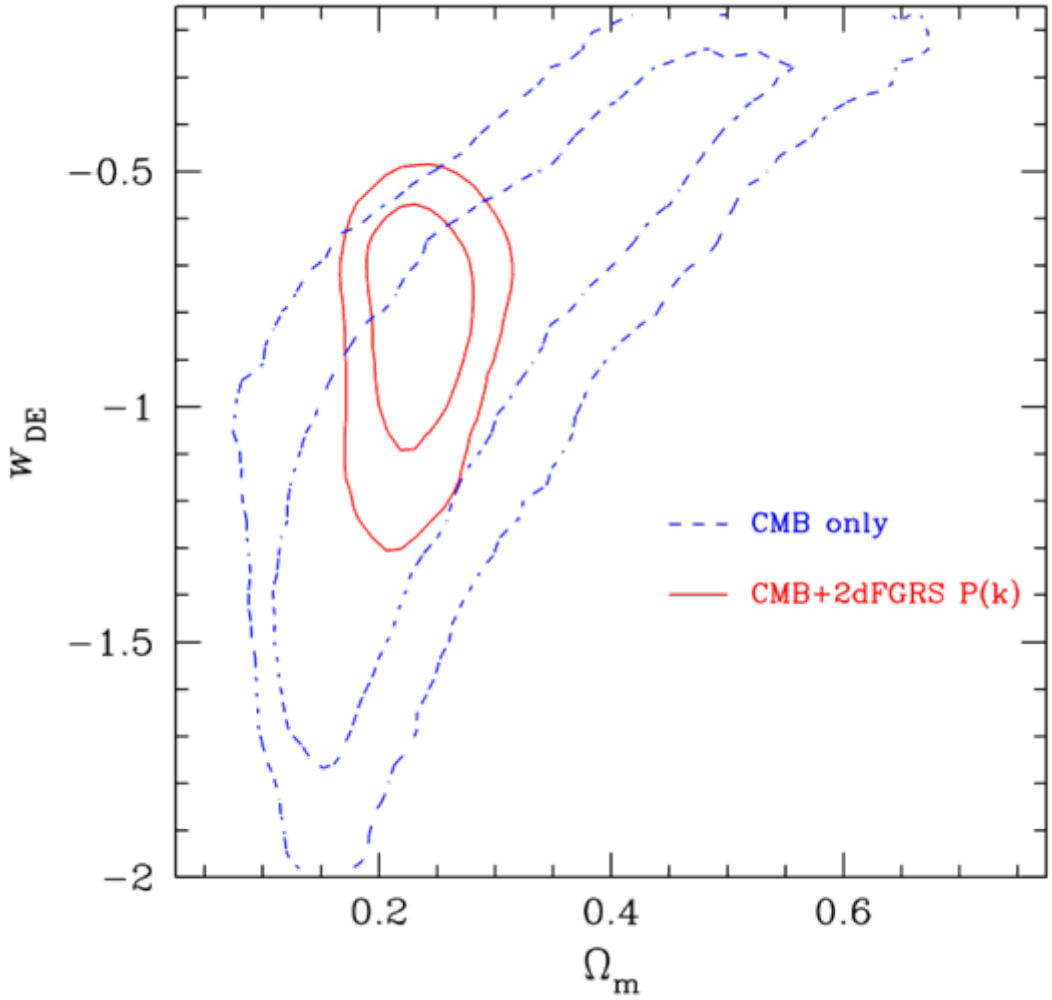

$$w_{DE} = -0.93^{+0.49}_{-0.47}$$

$$w_{DE} = -0.85^{+0.18}_{-0.17}$$

Sánchez et al. 2006

2dFGRS – SDSS tension

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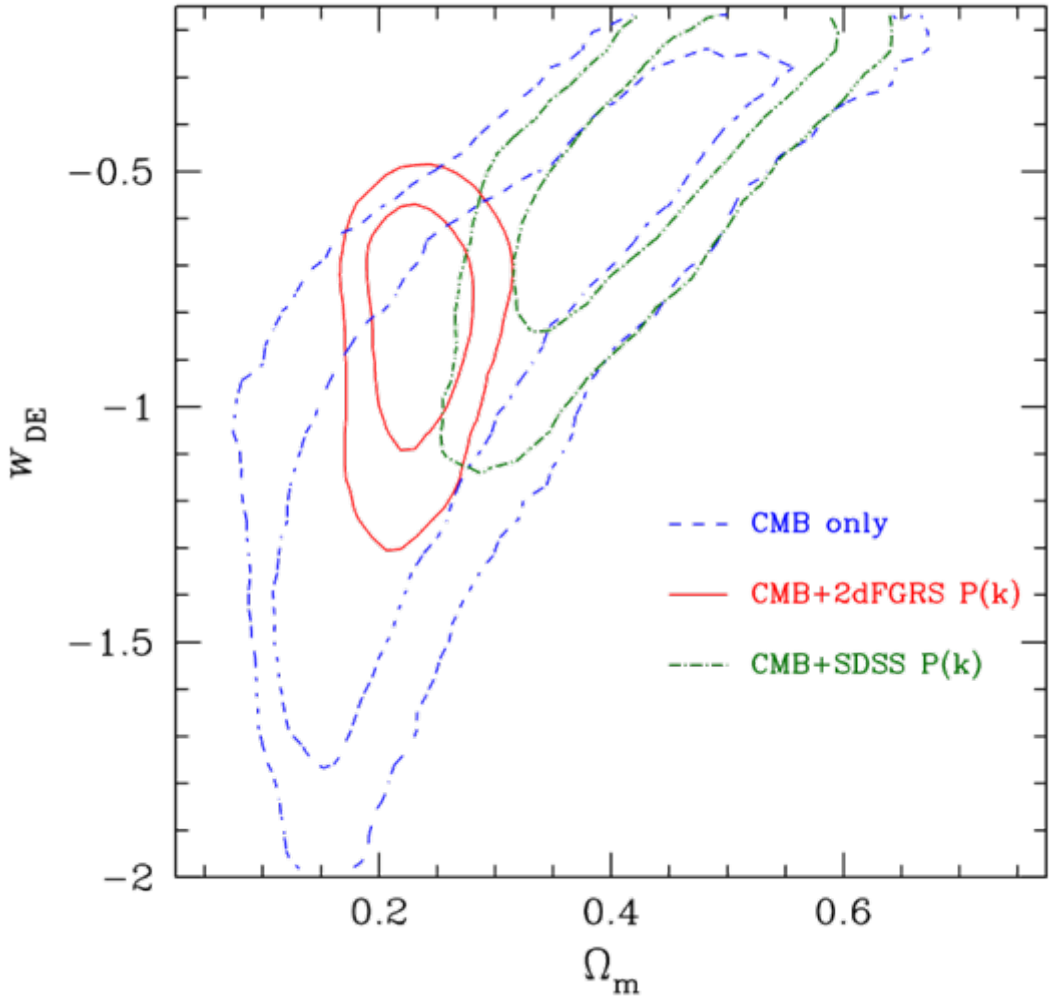


$w_{DE} = -0.93^{+0.49}_{-0.47}$

$w_{DE} = -0.85^{+0.18}_{-0.17}$

$w_{DE} = -0.45^{+0.23}_{-0.23}$

Sánchez et al. 2006

2dFGRS – SDSS tension

- Modelling of $P(k)$?

  - 2dFGRS: redshift space – SDSS: real space

- $P(k)$ estimator?

  - 2dFGRS: direct Fourier transform (PVP)

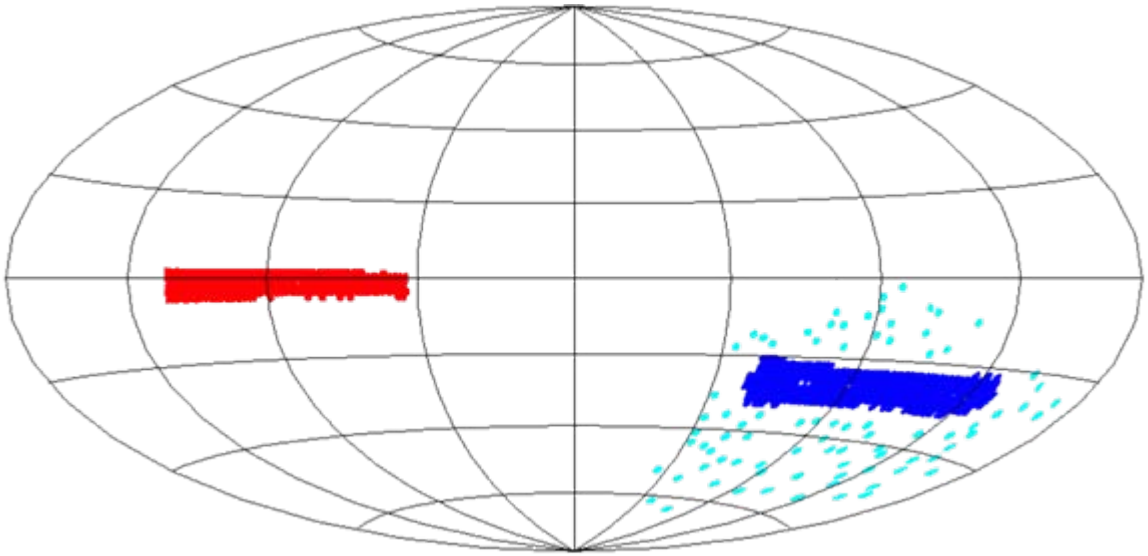
  - SDSS: fog compression, pseudo-Karhunen-Loève dec.

- Selection methods?

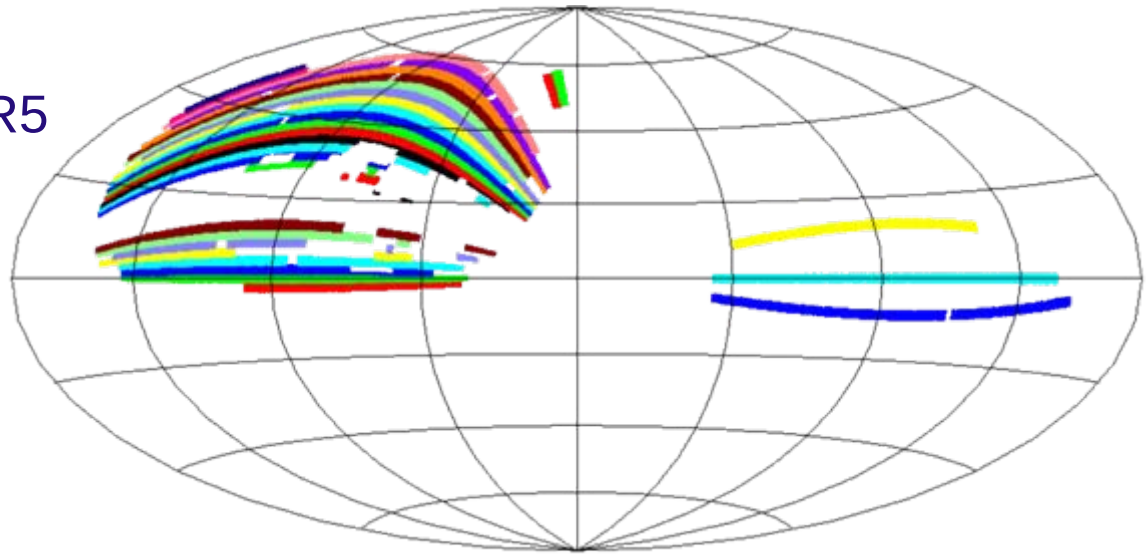
  - 2dFGRS: blue - SDSS: red.

2dFGRS – SDSS tension: survey overlap

2dFGRS

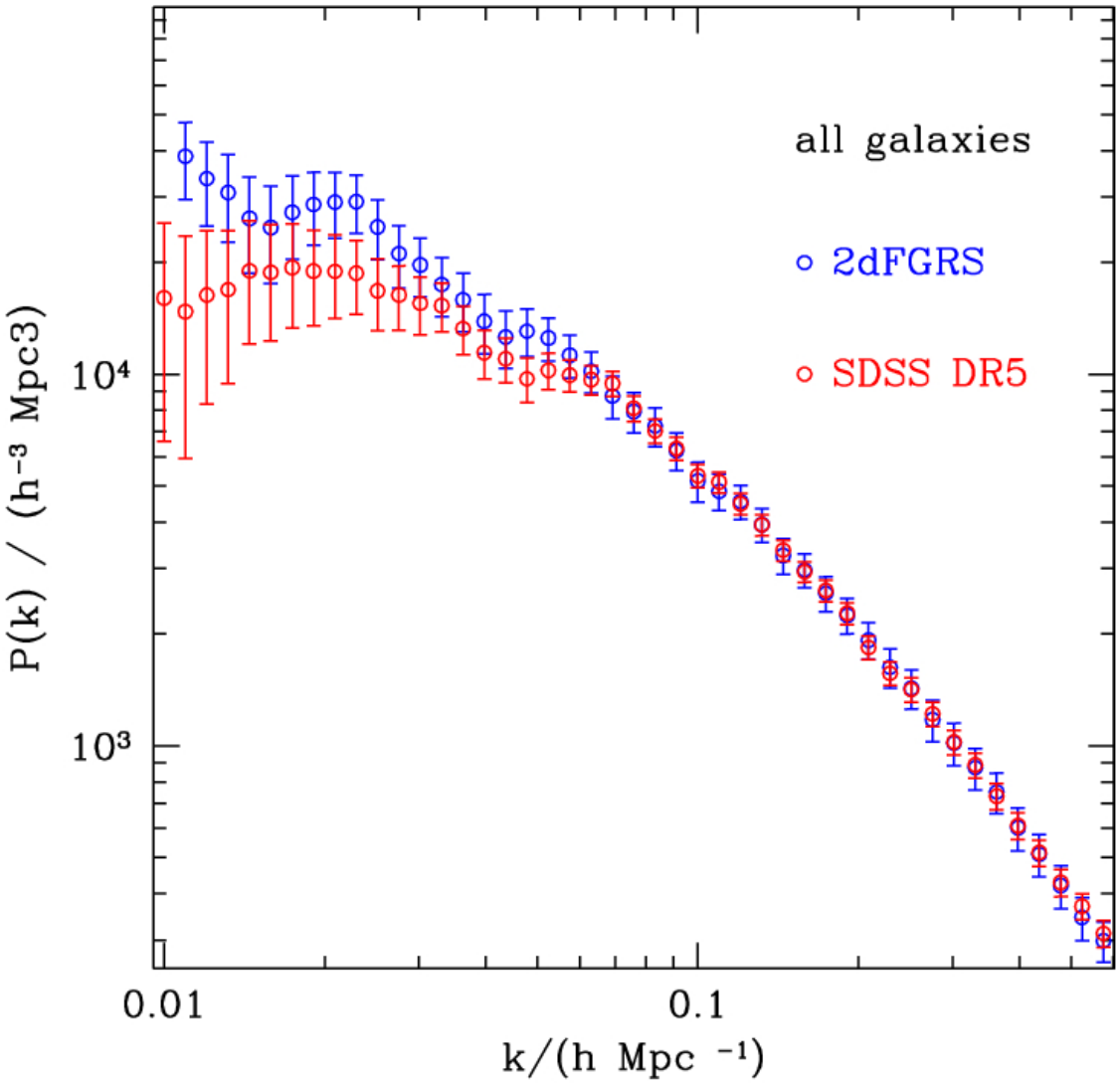


SDSS-DR5



Sánchez & Cole (2007)

Comparison of power spectra



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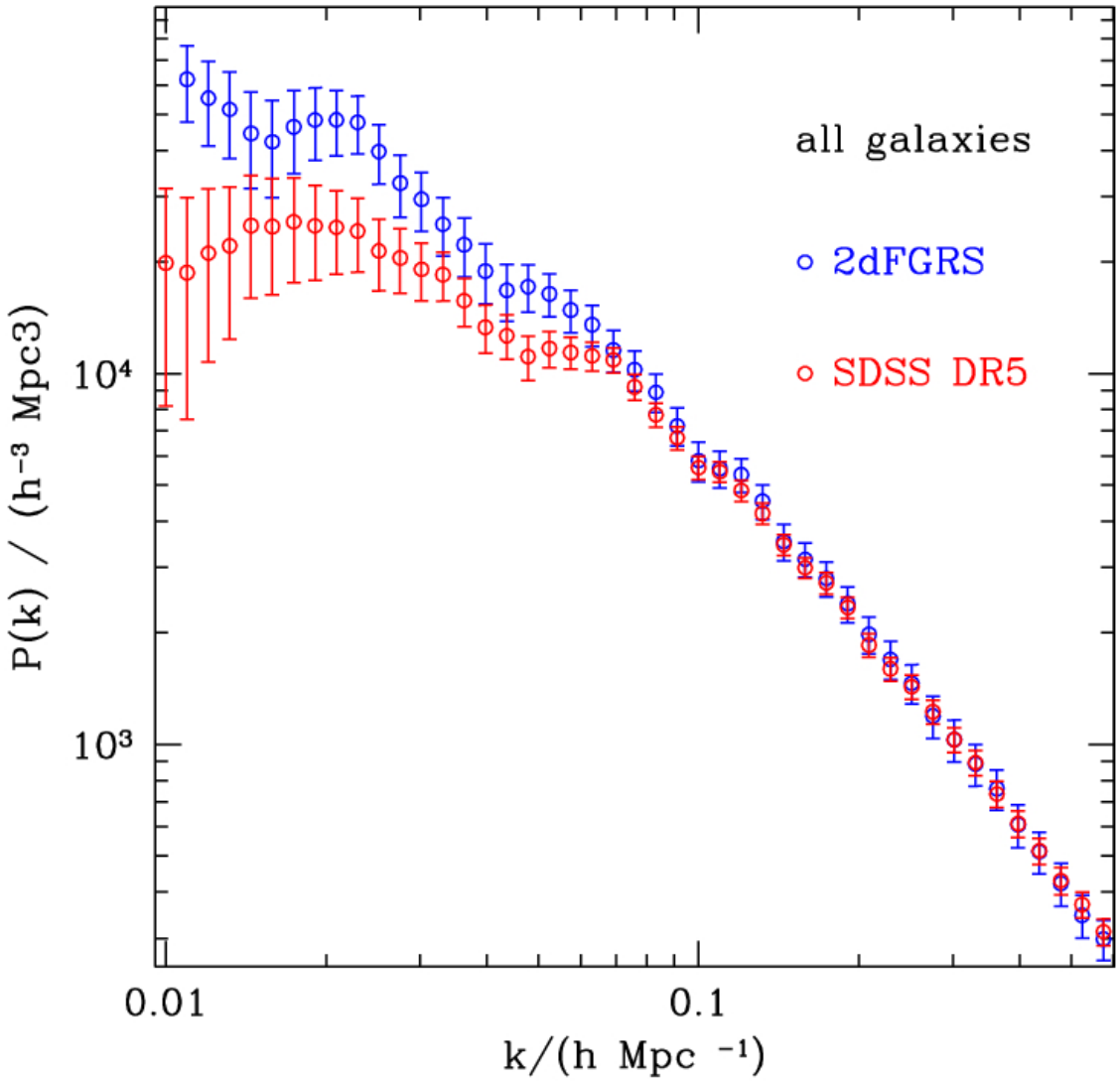

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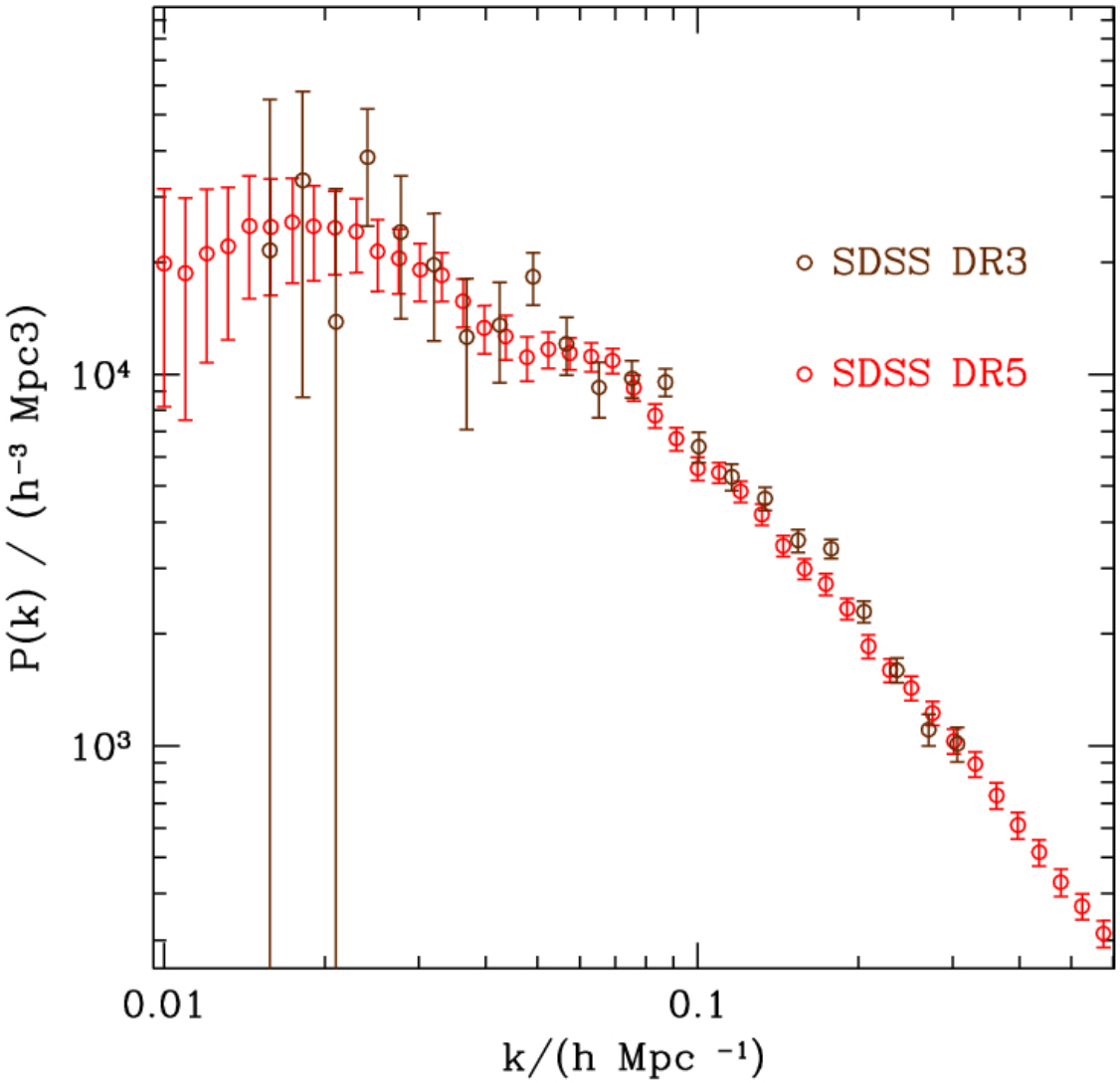


Comparison of power spectra

- The measured $P(k)$ differs from the mass power spectrum.

  - Non-linear evolution.
  - Redshift space distortions.
  - Galaxy bias.

- To model these effects

we applied the scheme of Cole et al. (2005)

$$P_{\rm gal}(k) = b^2 \frac{1+Qk^2}{1+Ak} P_{\rm lin}(k)$$

where $A = 1.4$ and Q depends on galaxy type.

Comparison of power spectra

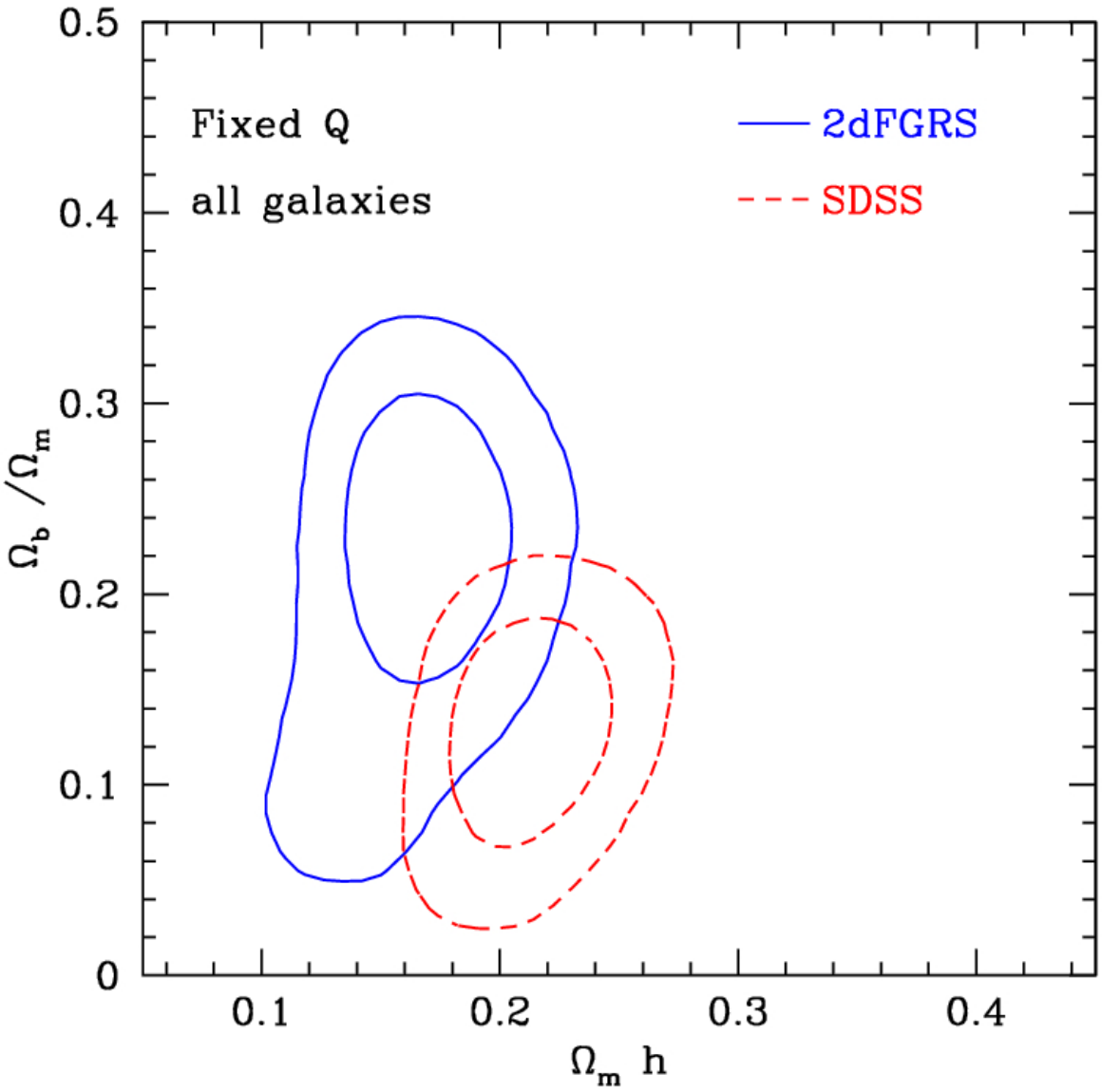
- We explored the parameter space

$$P = (\Omega_b / \Omega_m, \Omega_m h, Q)$$

- We use only the shape of $P(k)$ and no CMB data

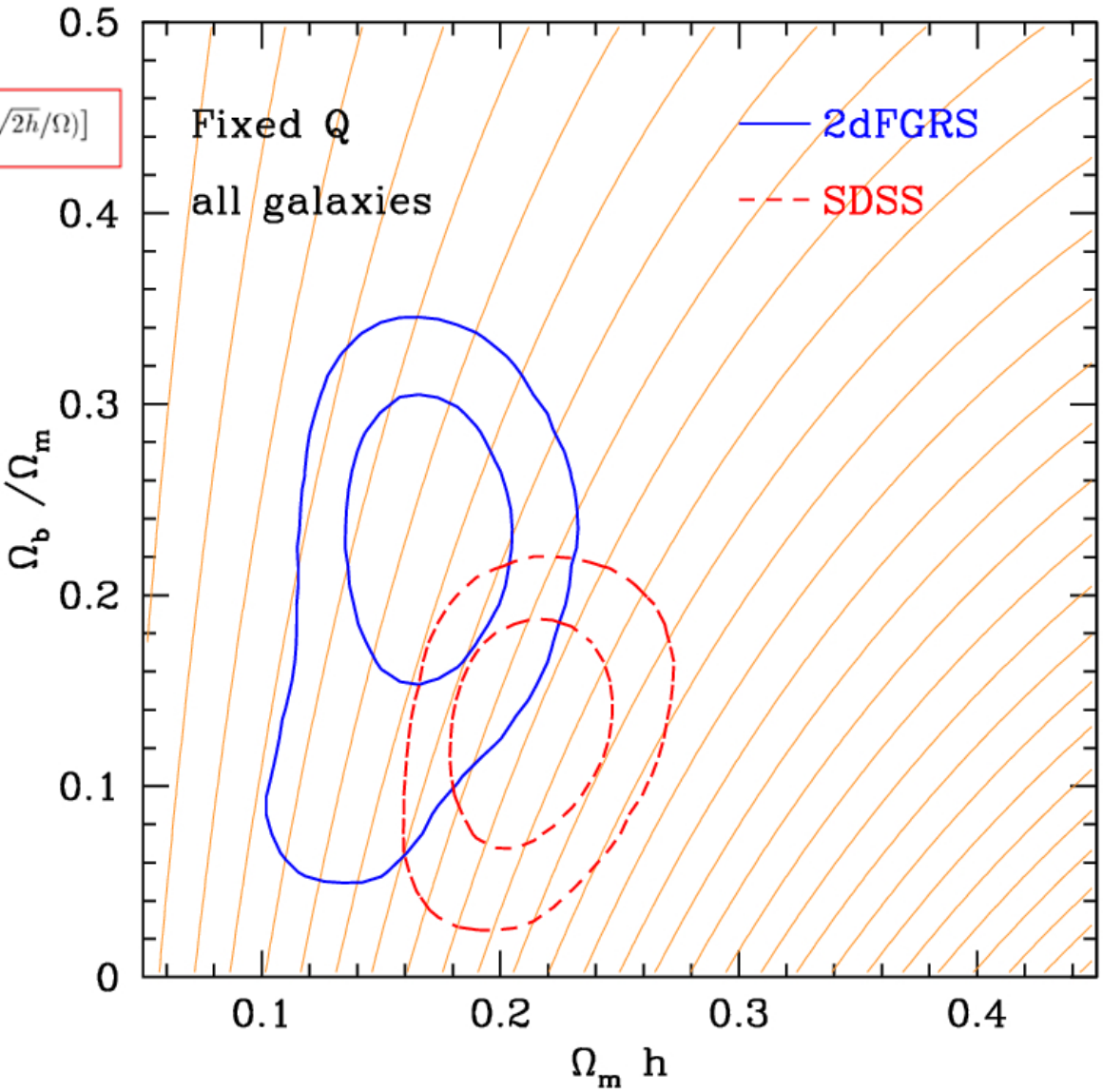
$$0.02\ h\ \mathrm{Mpc}^{-1} < k < 0.2\ h\ \mathrm{Mpc}^{-1}$$

Comparison of power spectra



Comparison of power spectra

$$\Gamma \equiv \Omega h \exp[-\Omega_B(1+\sqrt{2h}/\Omega)]$$



Comparison of power spectra

- Red galaxies live in denser environments, stronger non-linear effects.

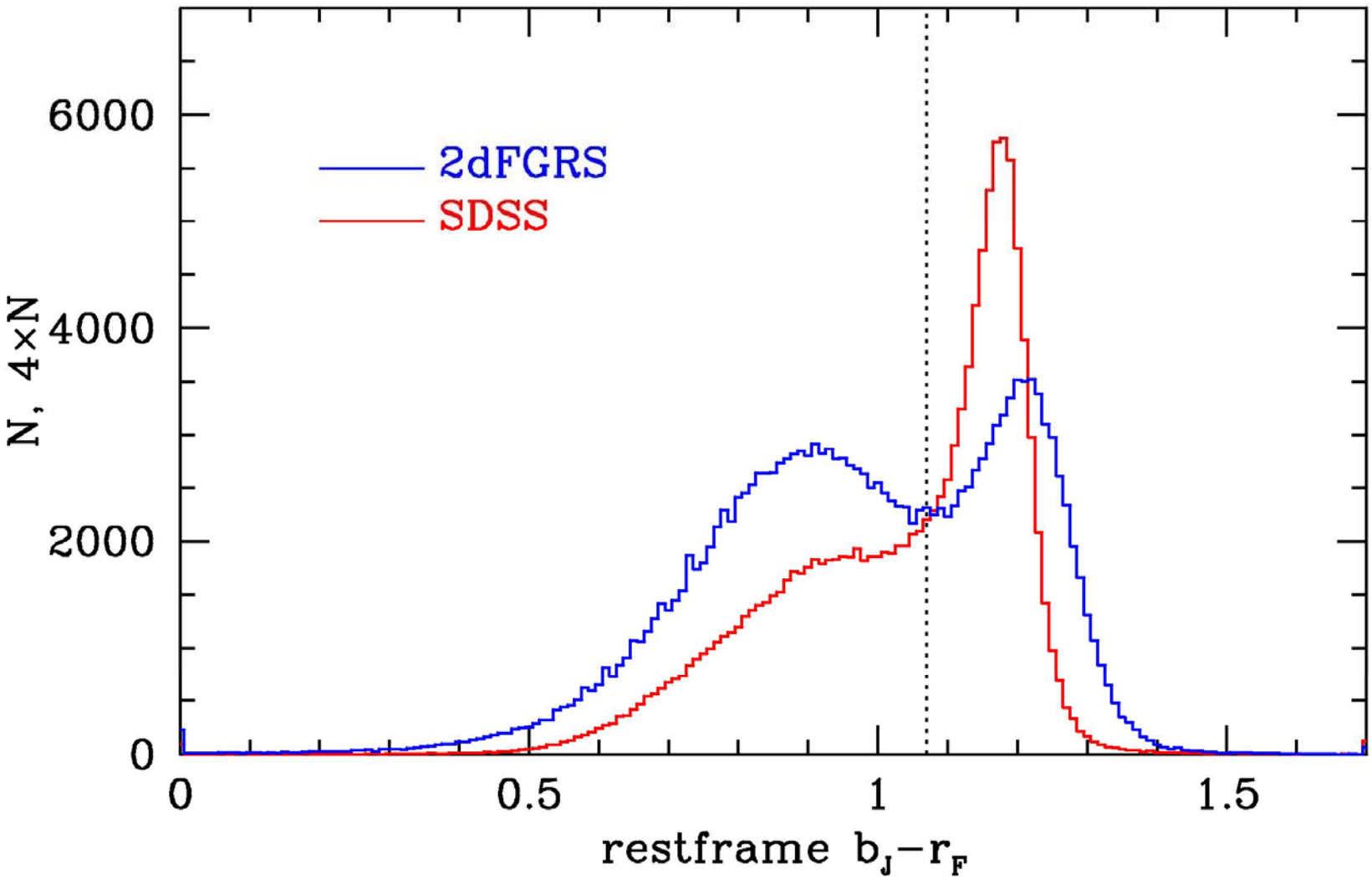
- We can convert SDSS magnitudes to 2dFGRS bands

$$b_{\mathrm{j}} = g + 0.15 + 0.13(g - r)$$

$$r_{\mathrm{F}} = r - 0.13$$

- How are the relative populations of red and blue galaxies?

Comparison of power spectra



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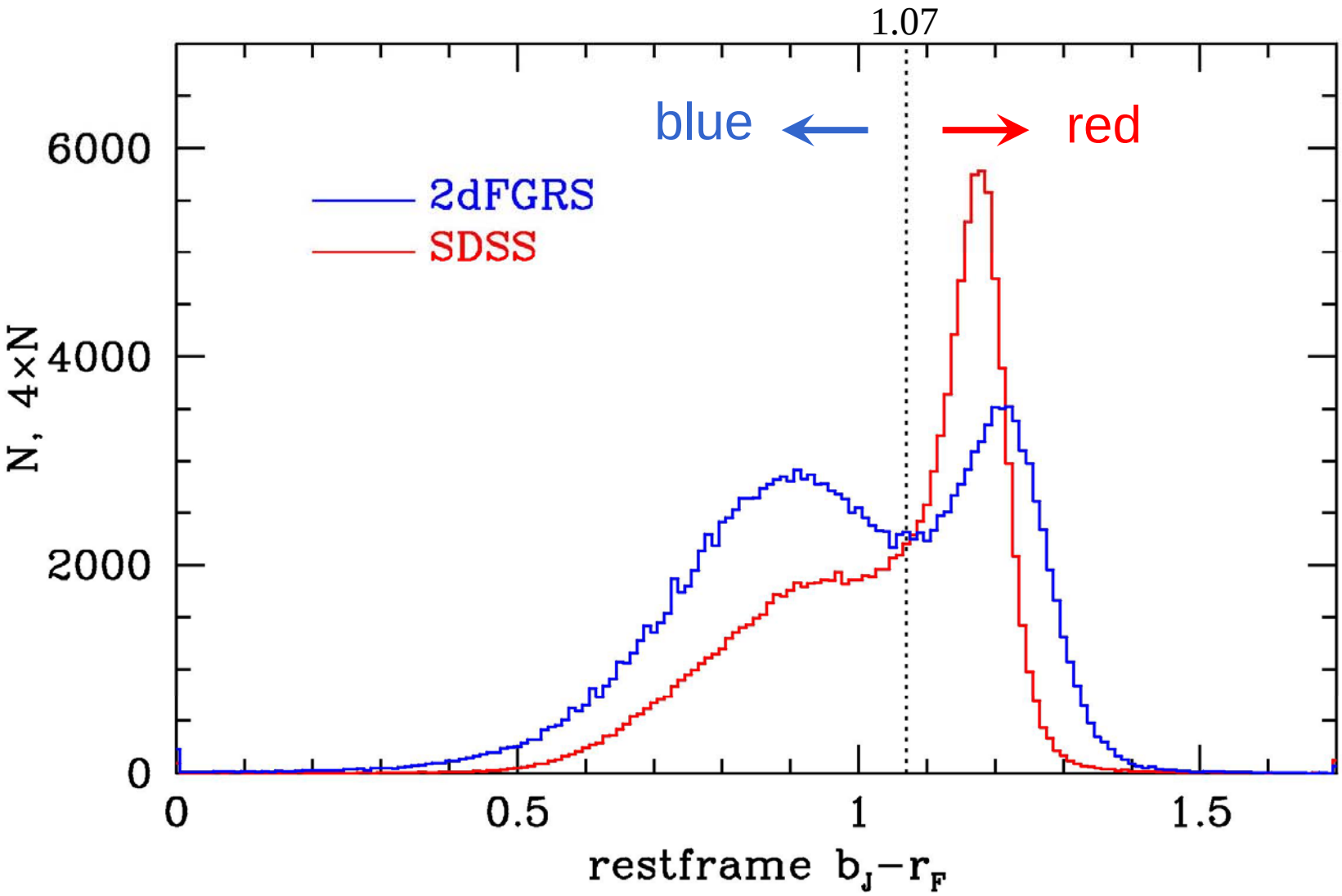

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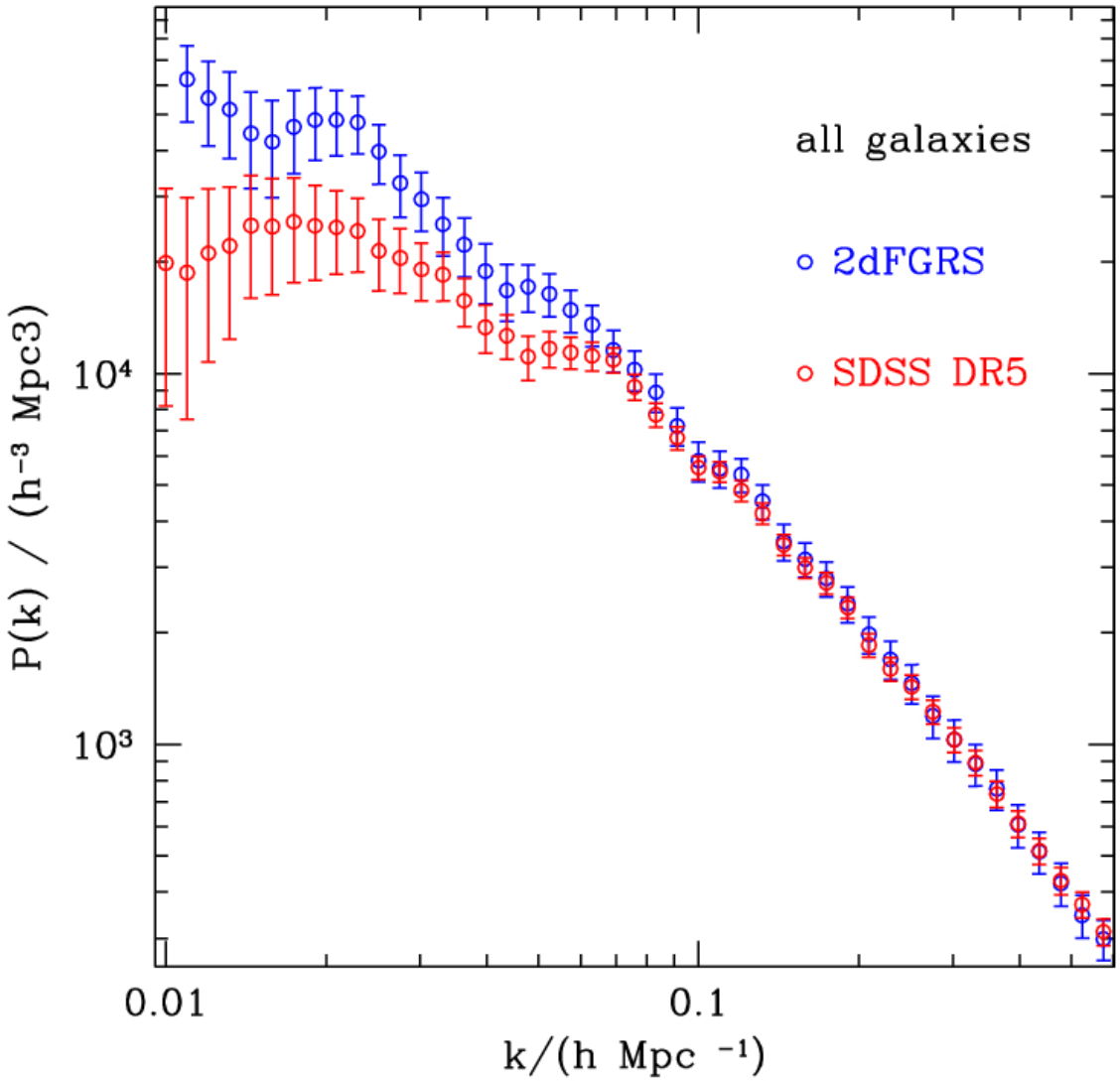

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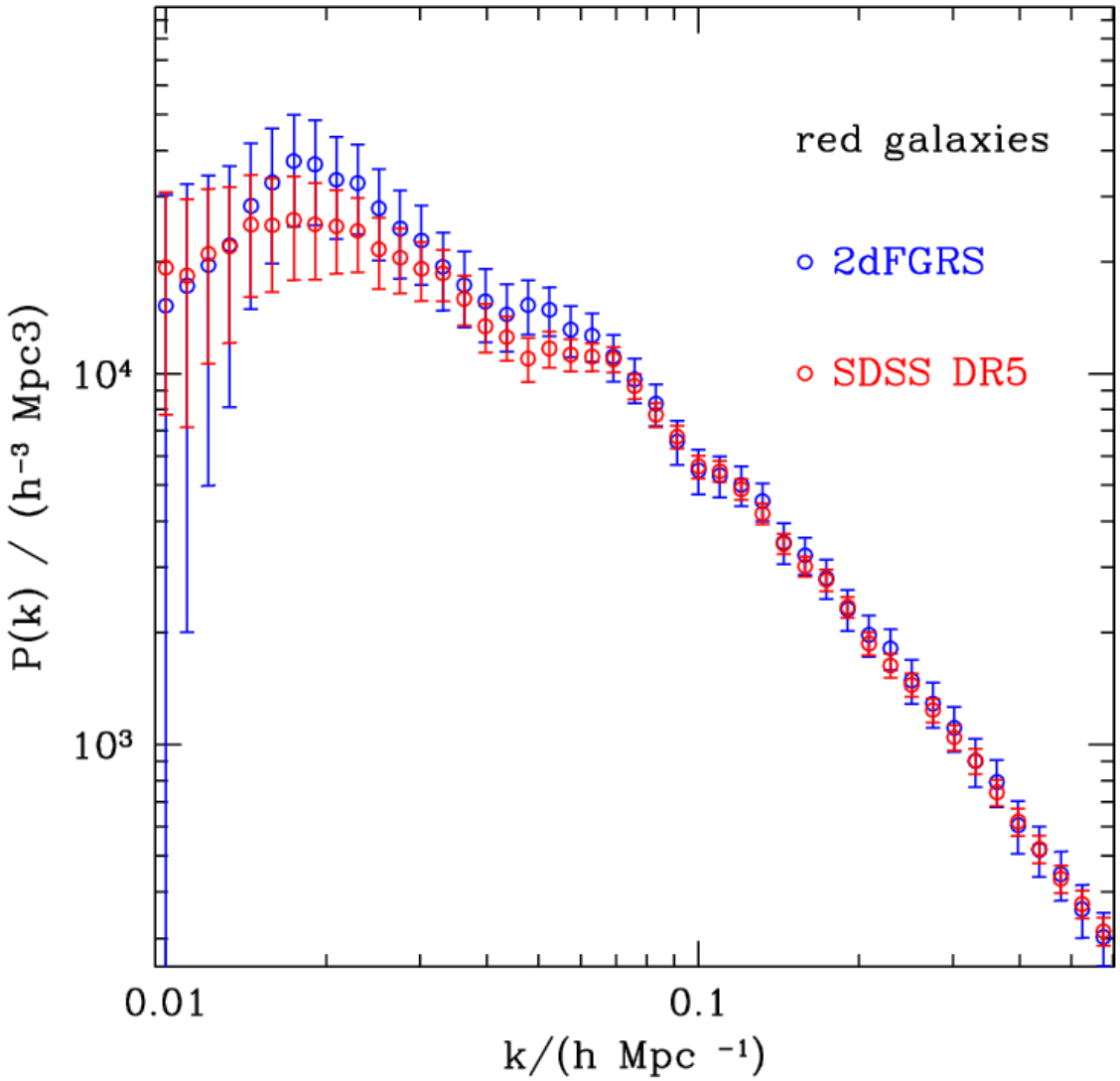

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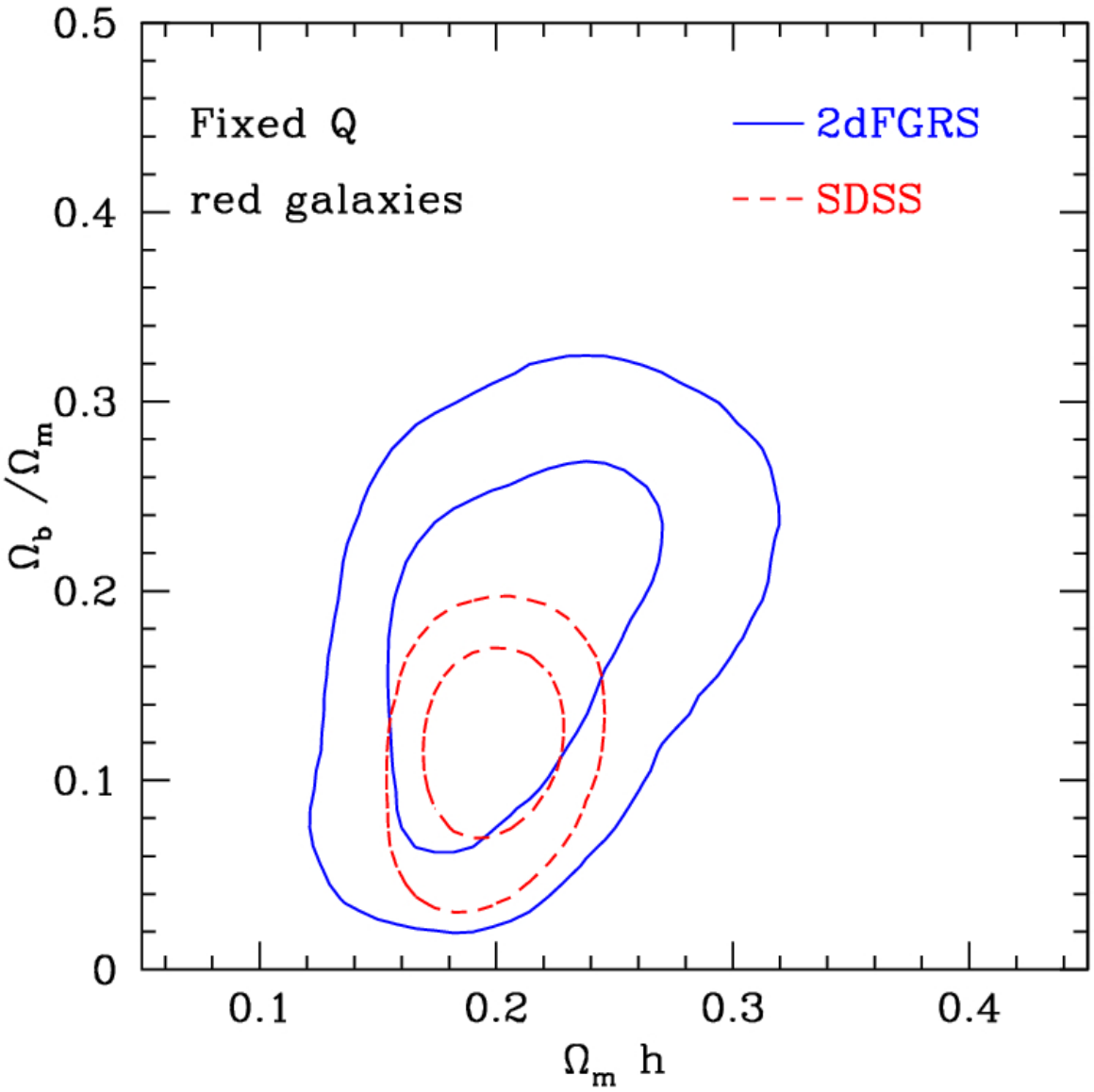

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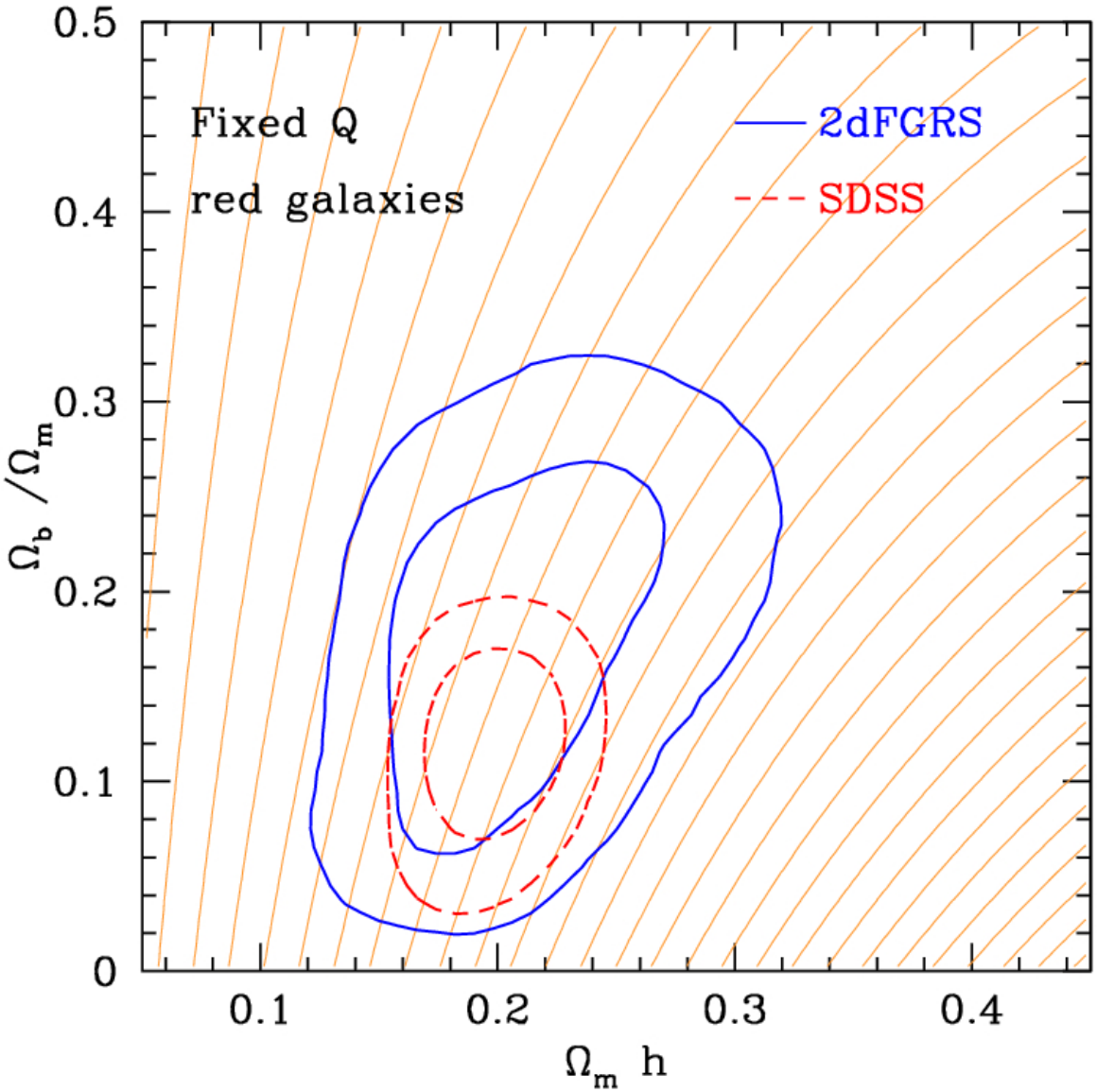


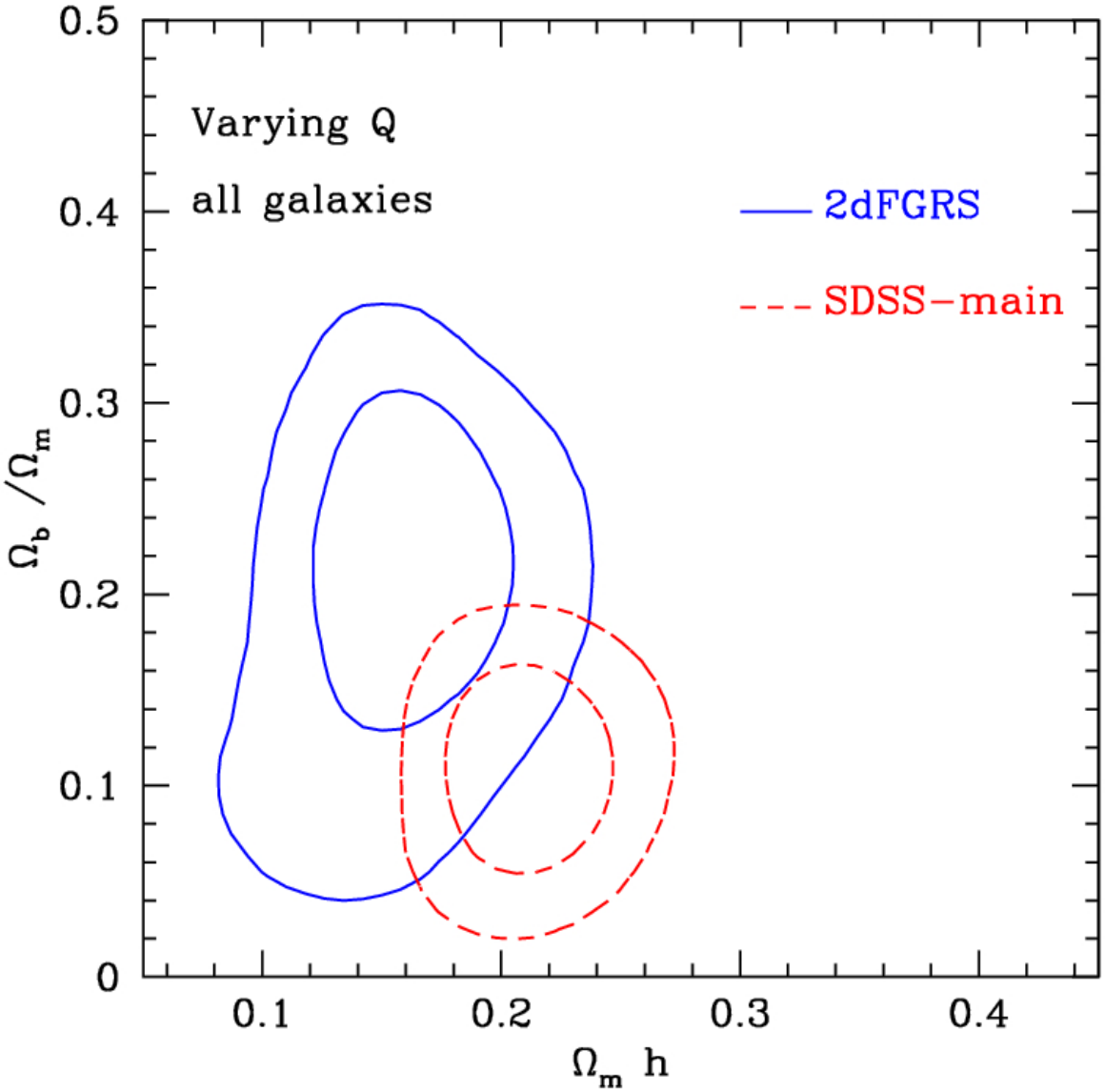
The shape of $P(k)$: varying Q

• We test if the differences between 2dFGRS and SDSS can be accounted for by using different values of Q.

• Cole et al. model was designed for 2dFGRS where the correction is small.

• It has been used to model $P(k)$ for redder and more luminous galaxy samples.

The shape of $P(k)$: varying Q



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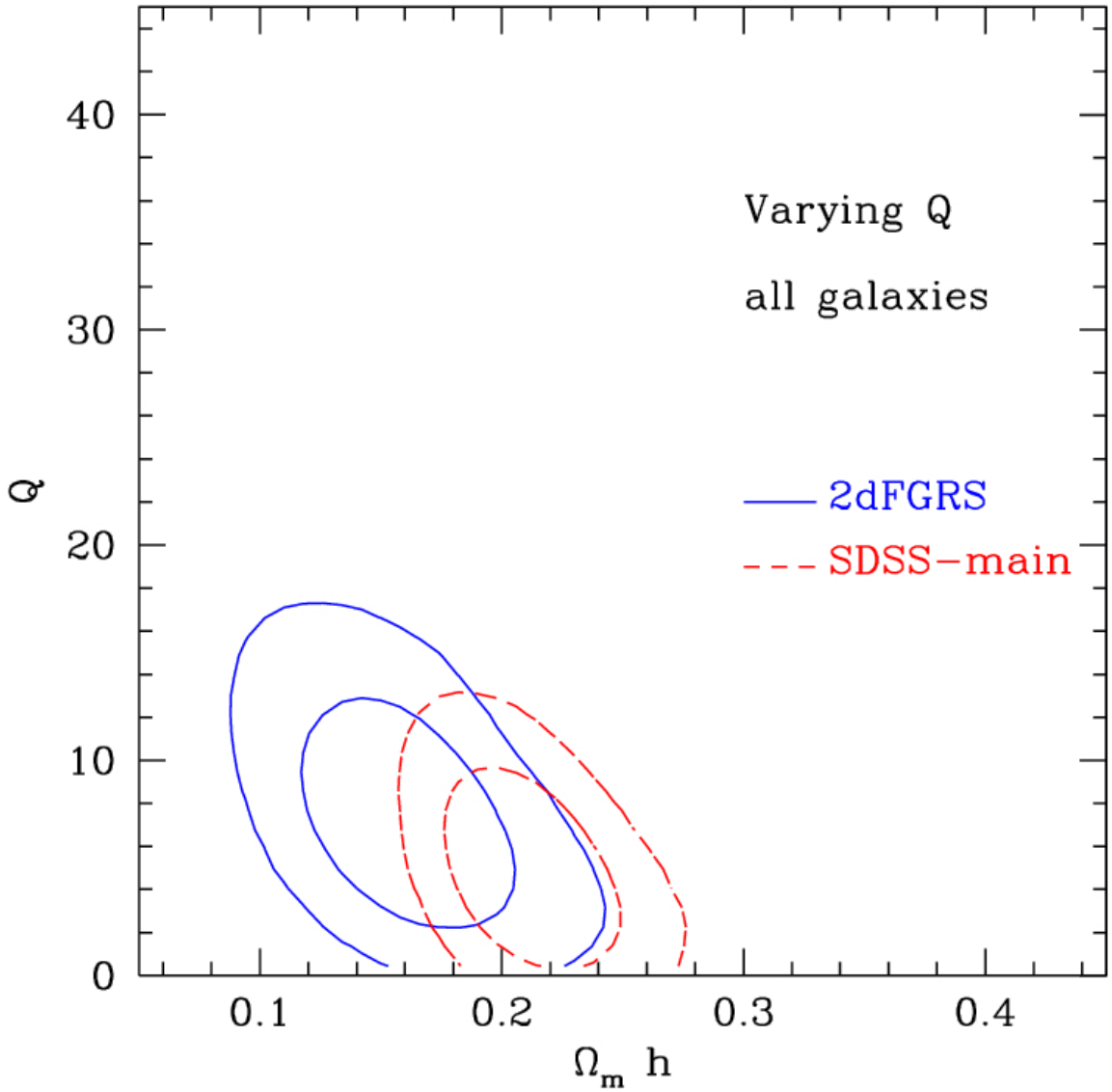

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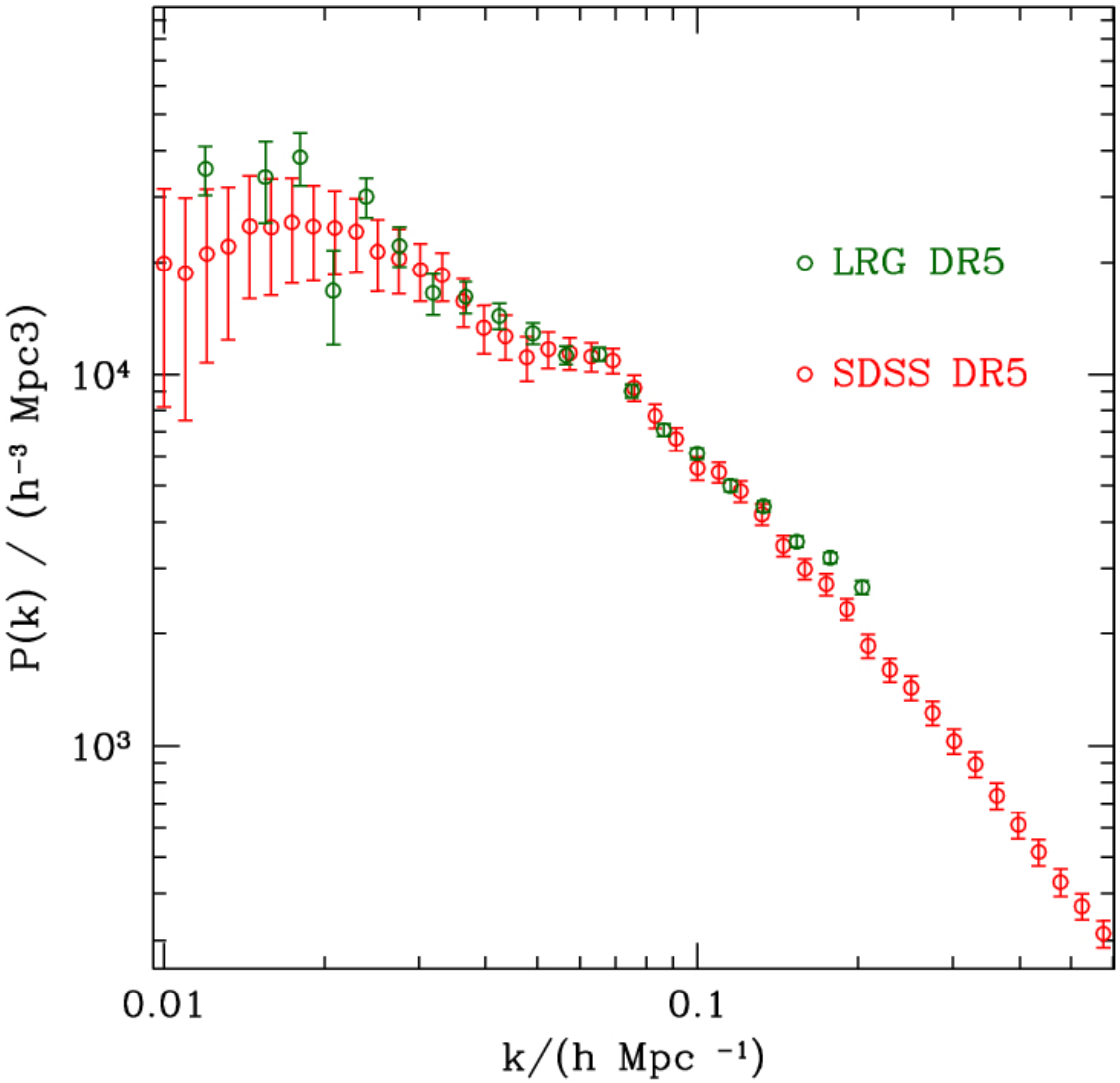

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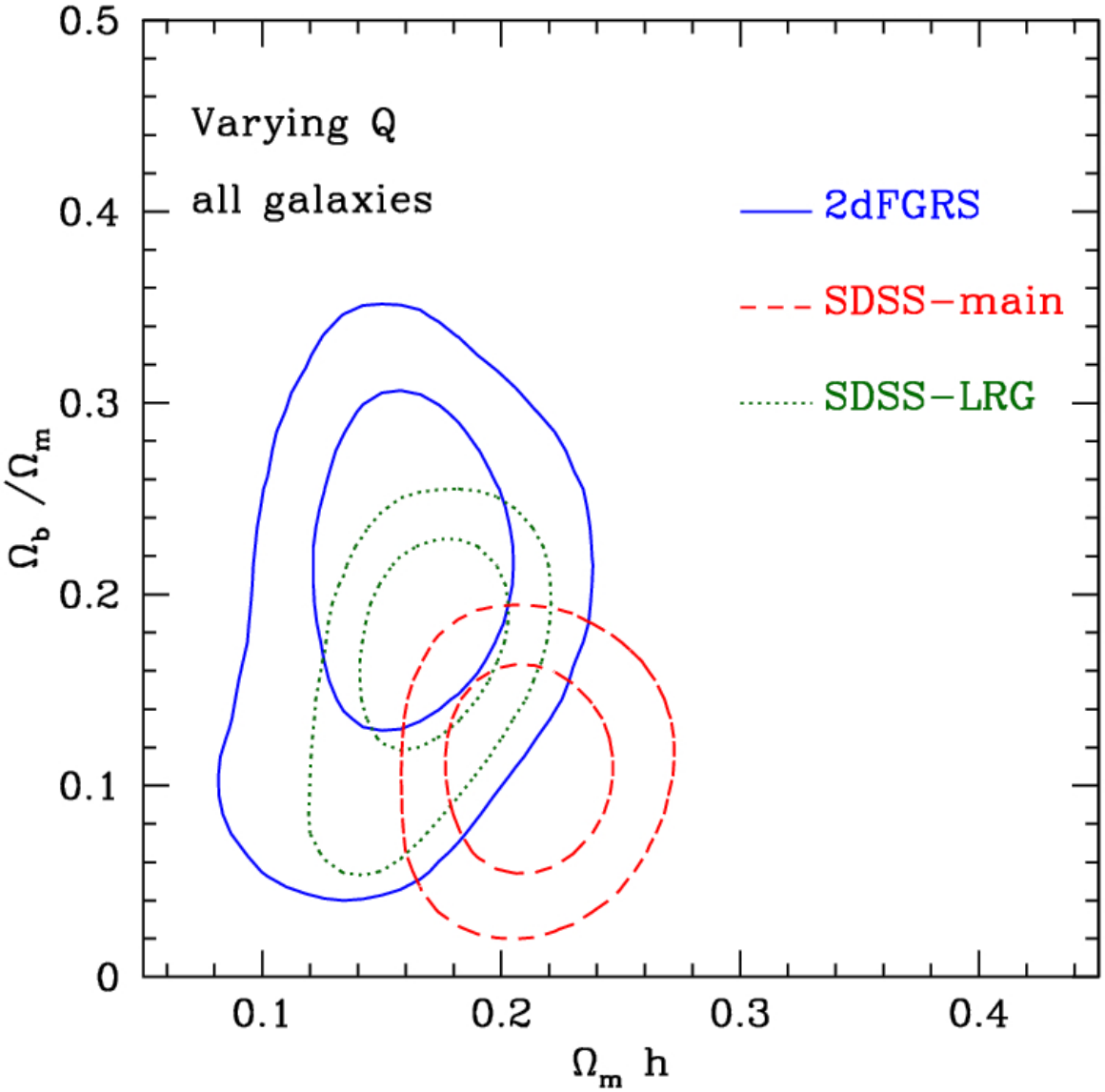

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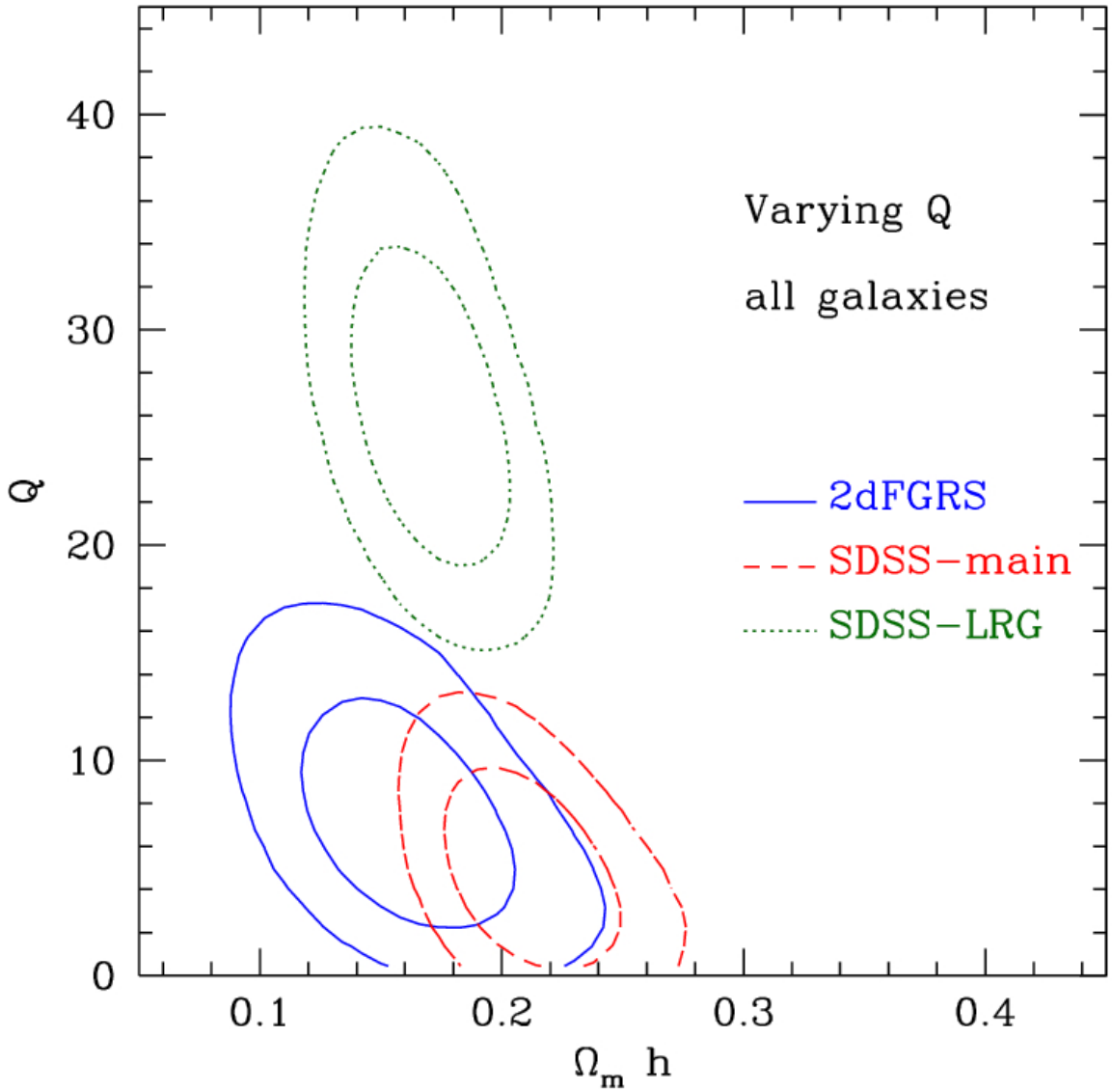

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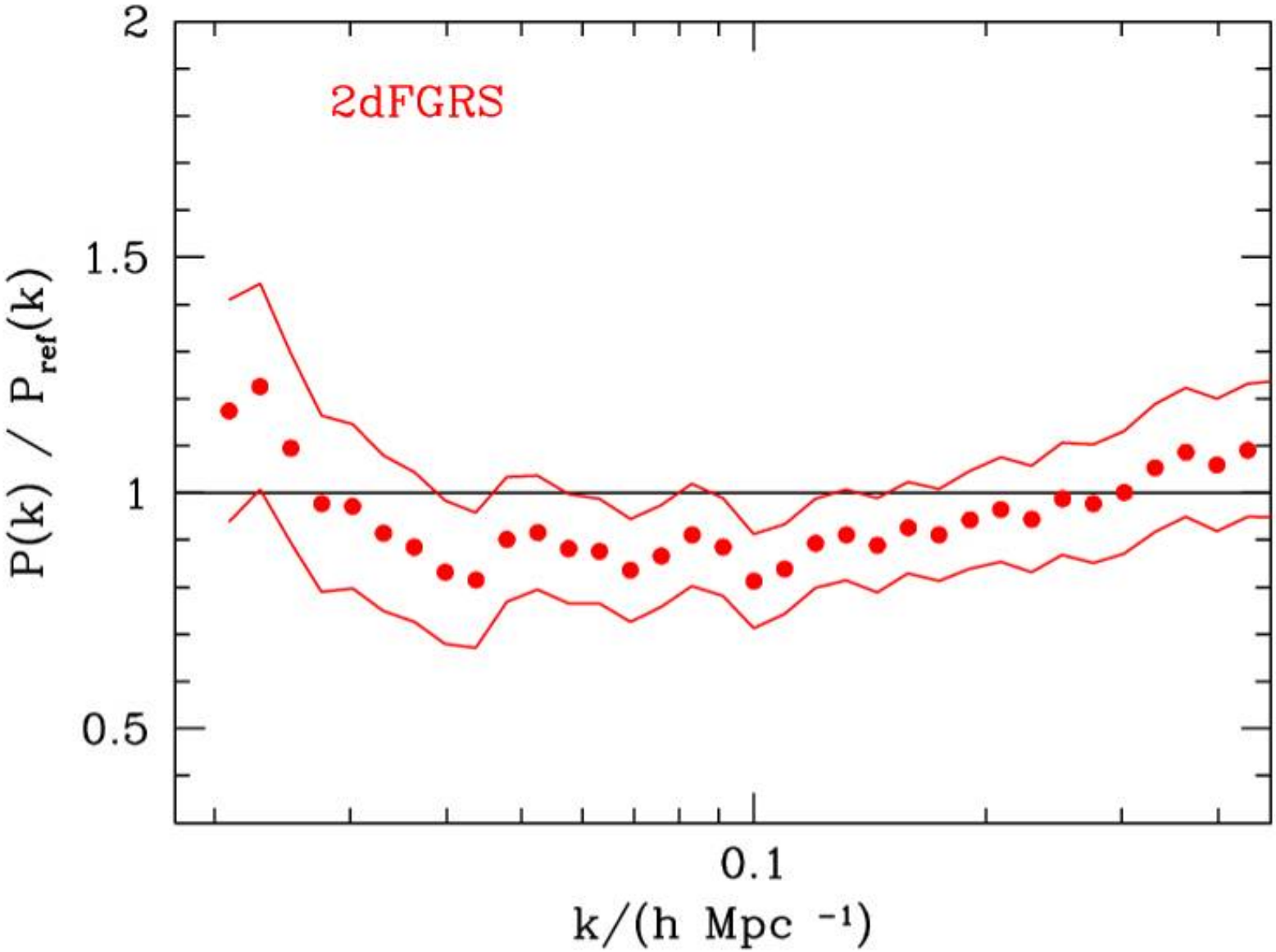

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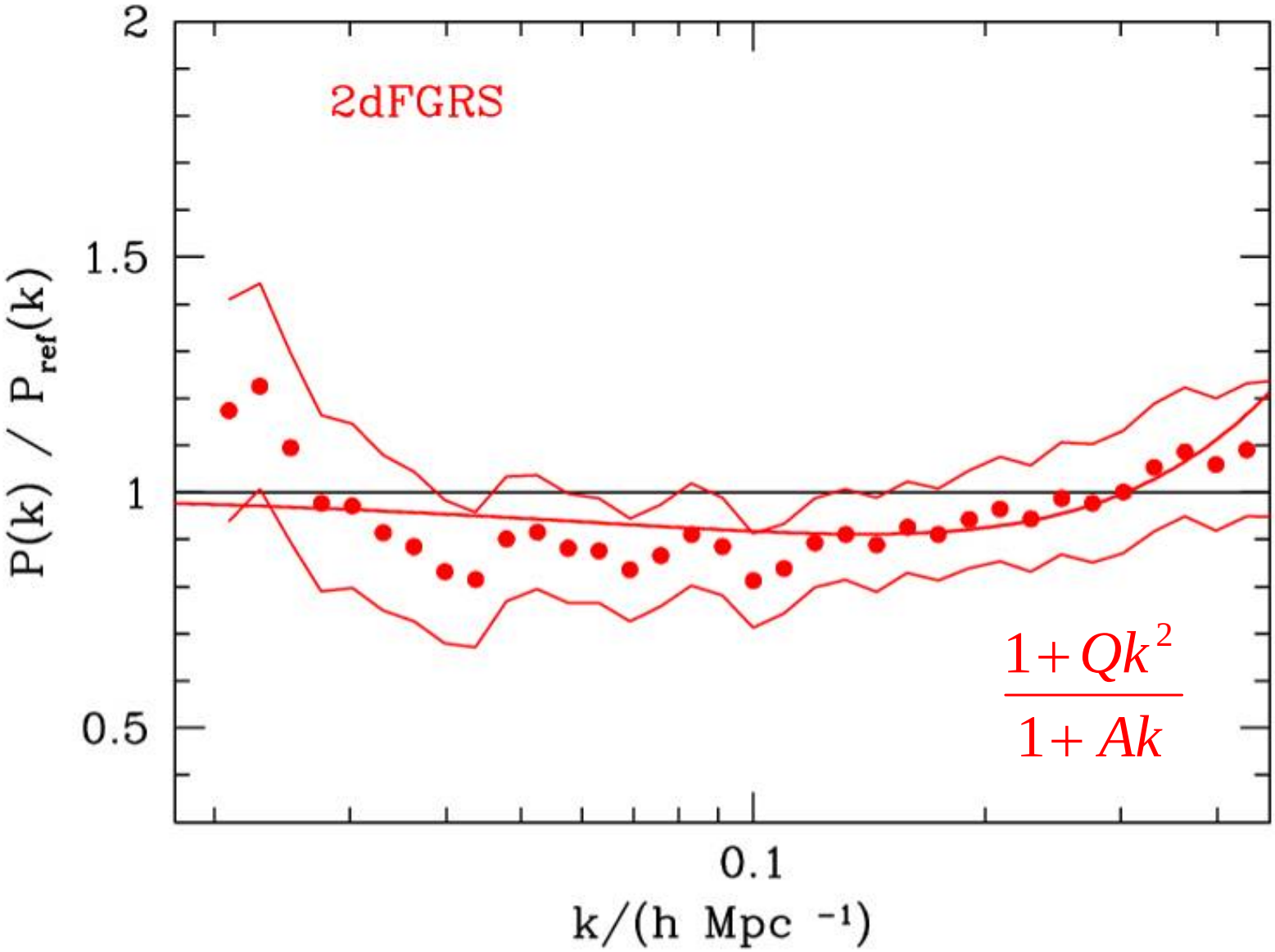

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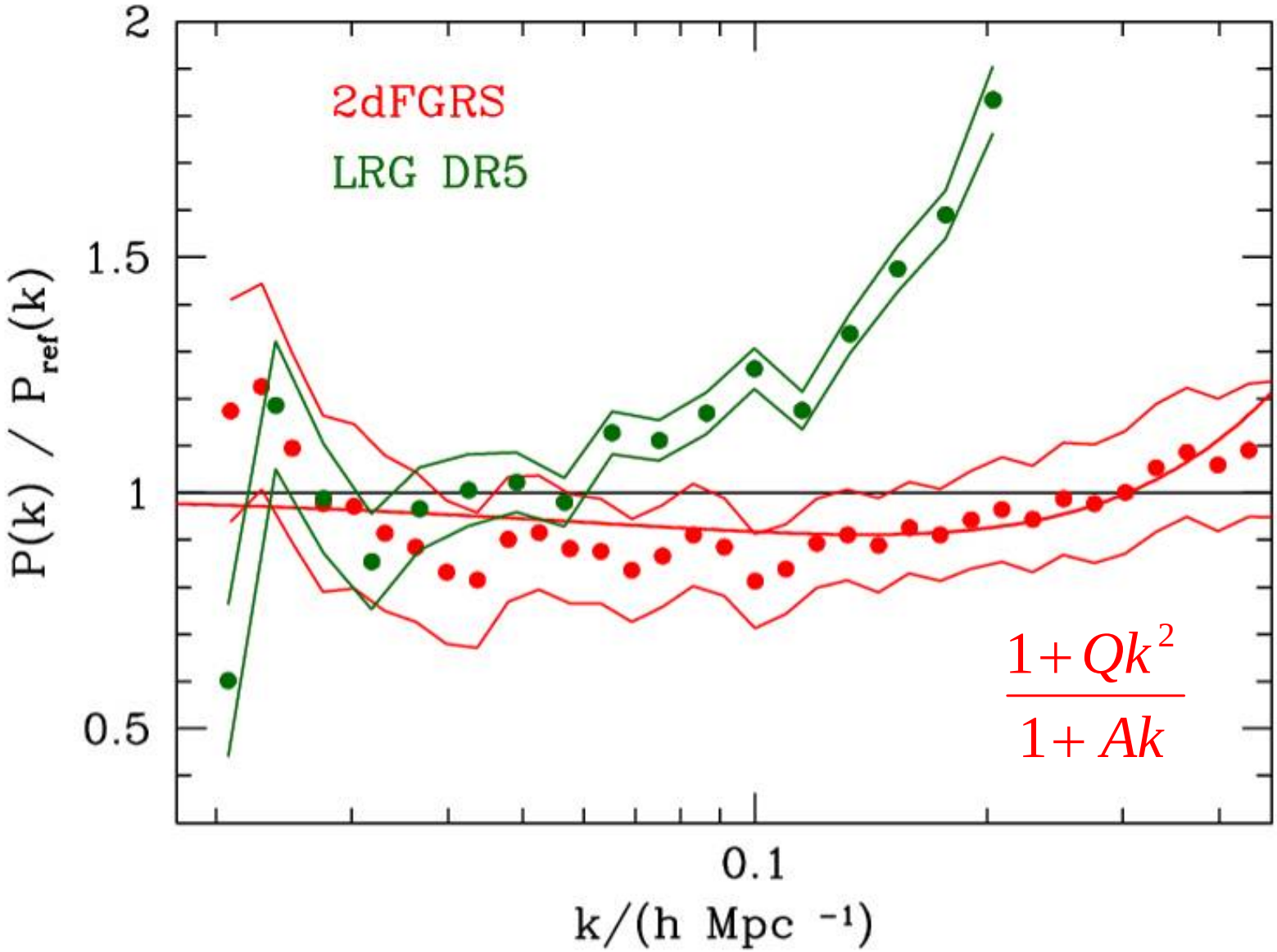

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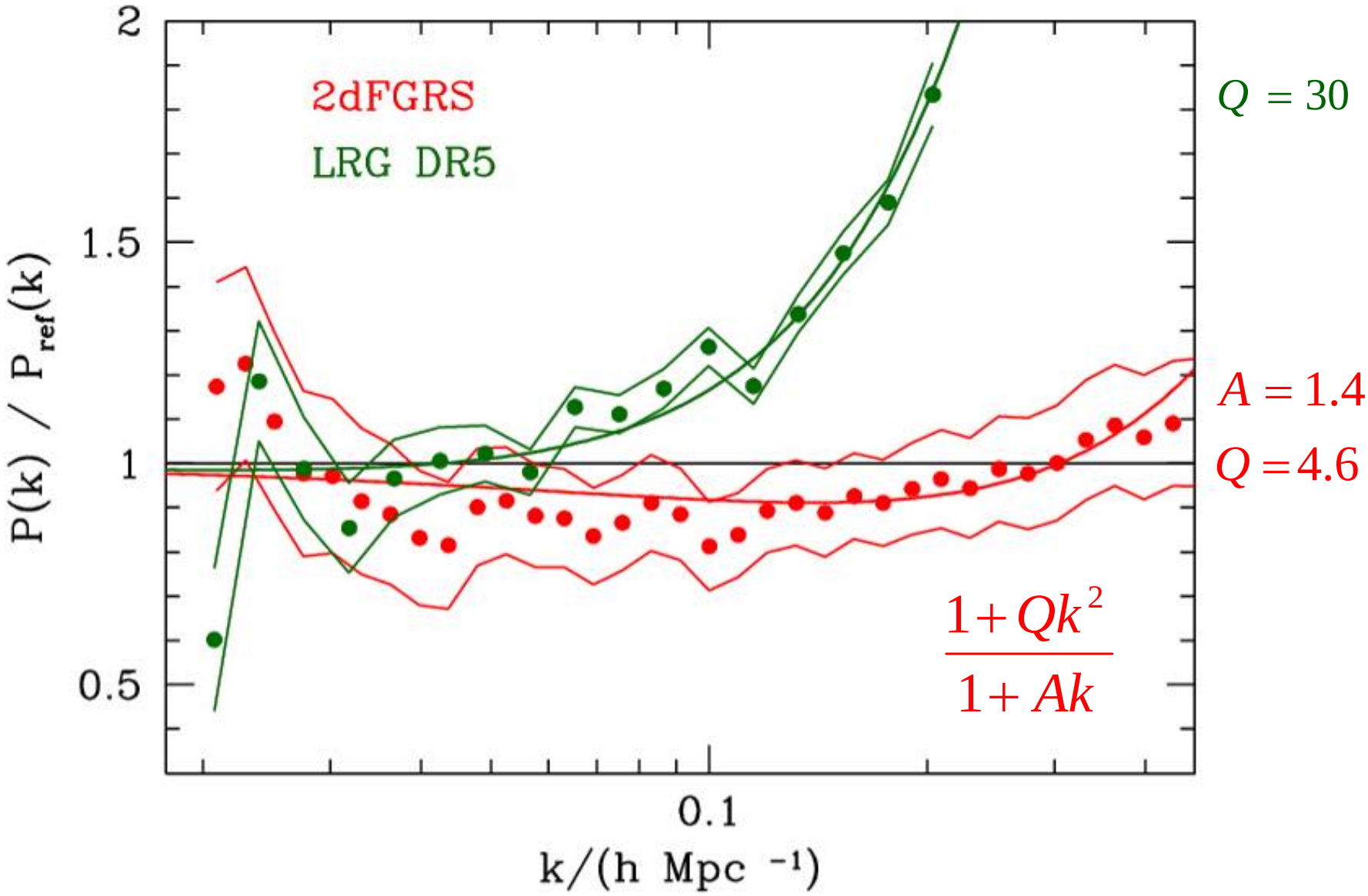

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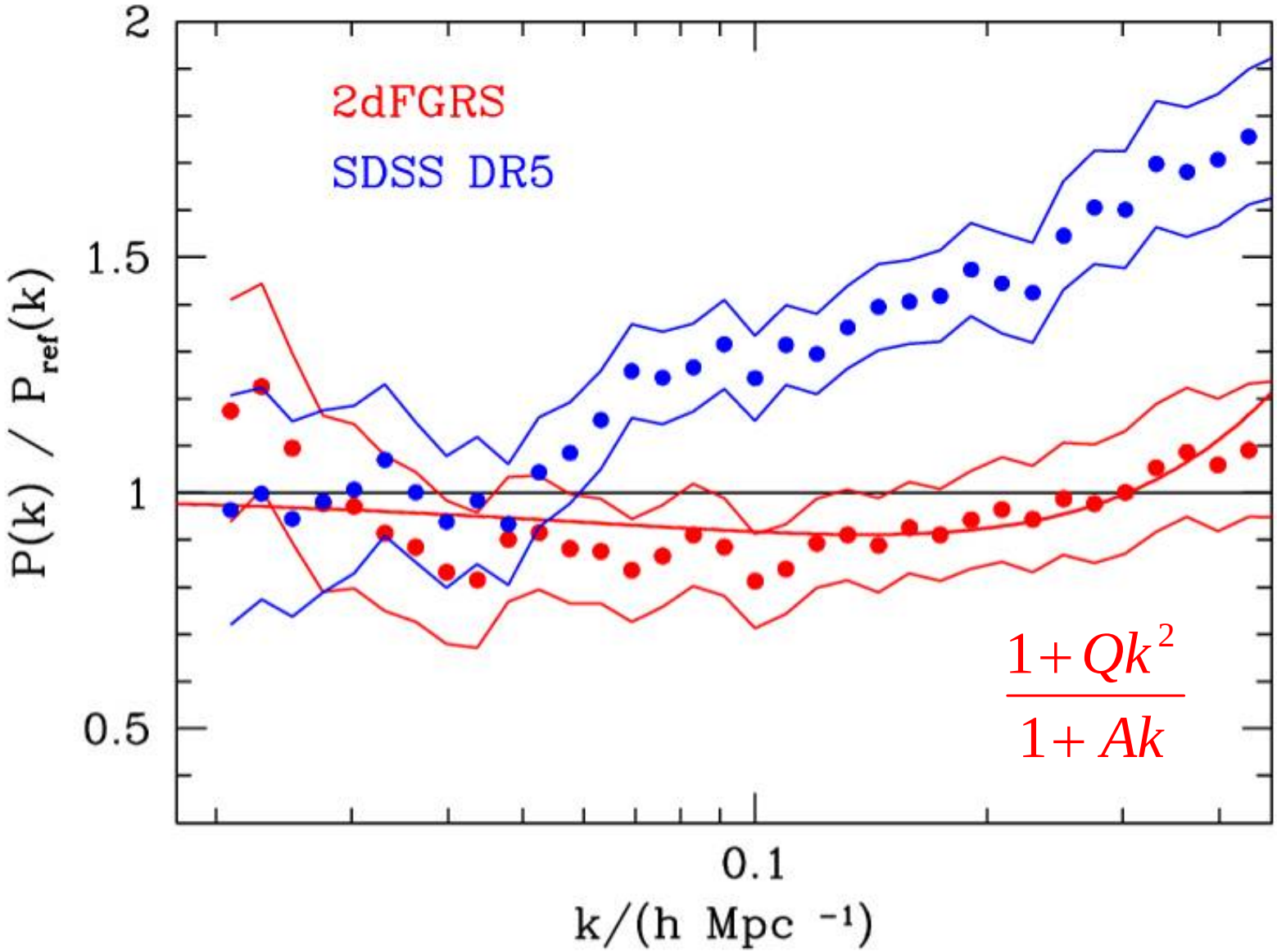

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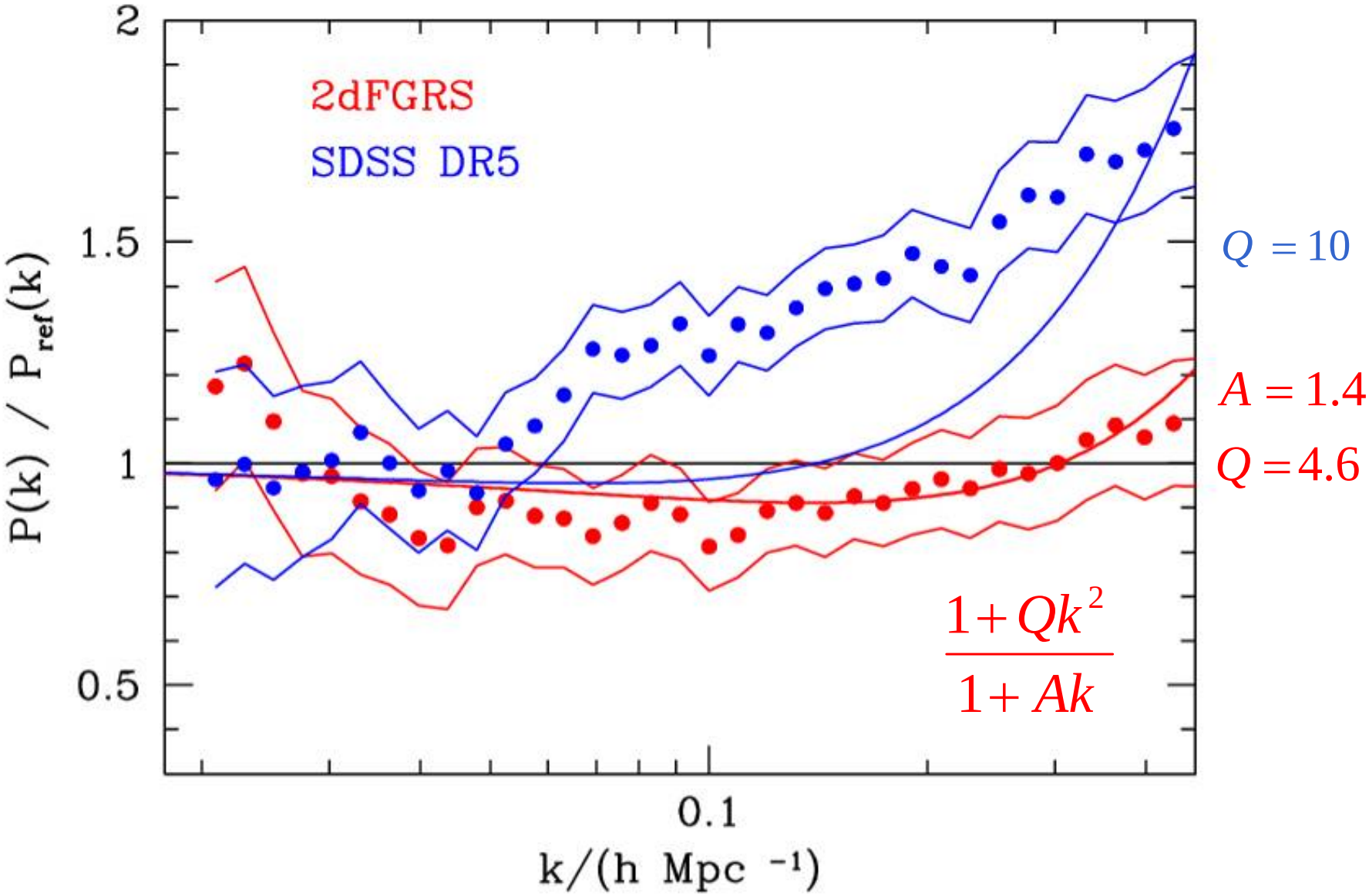

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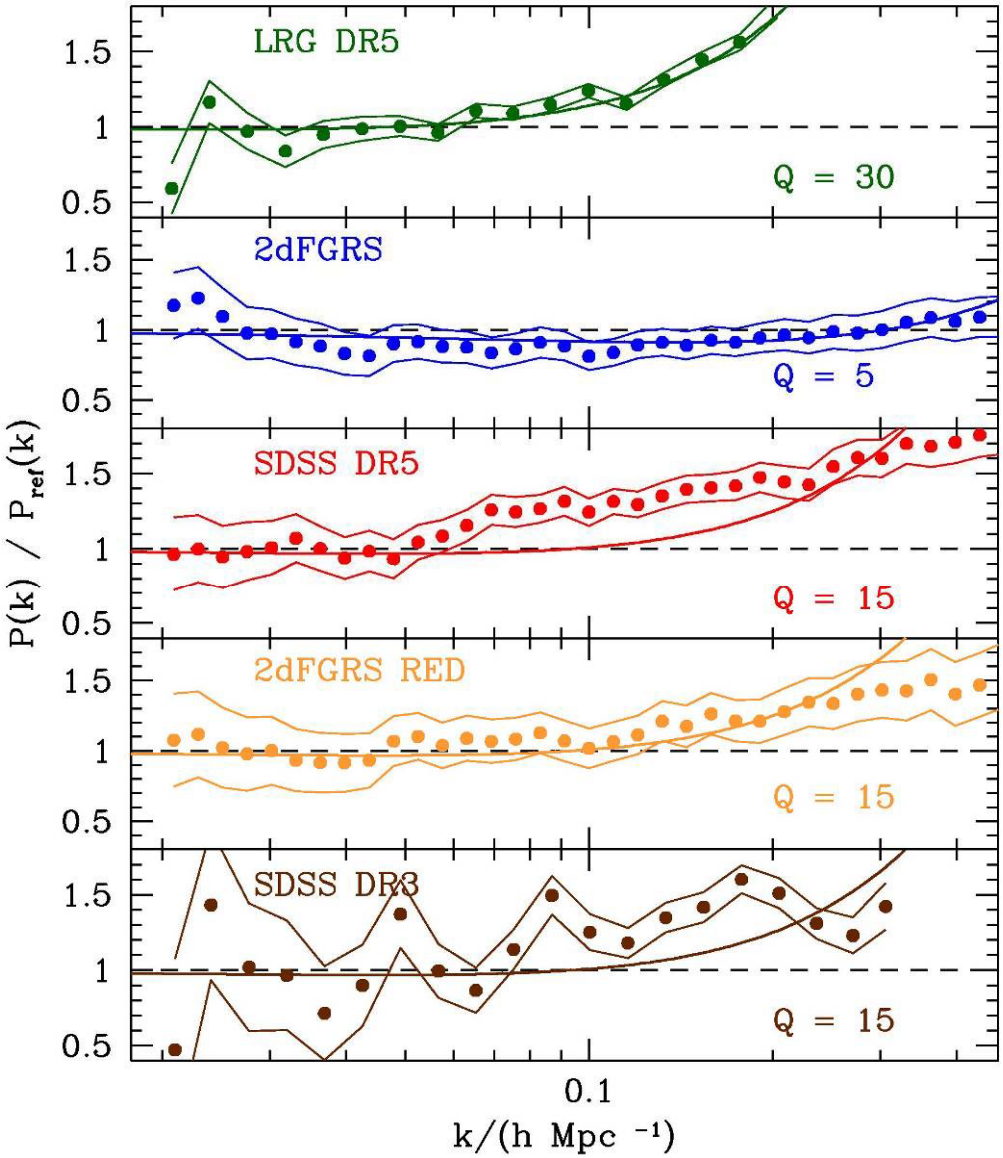

Final remarks

- There is tension between 2dFGRS and SDSS.

- This is due to the r-band selection of the SDSS.

- The simple model from Cole et al. is not able to reconcile these datasets.

- Key problem: how to relate theory and observations.

Final remarks

- We need to better understand non-linear effects and galaxy bias.

- Important to correctly interpret future galaxy surveys: Pan-STARRS, DES.

- This will push our current understanding of cosmology.

Thank you!

DARK ENERGY
Survey