

How accurate is our knowledge of the galaxy bias?

Surhud More

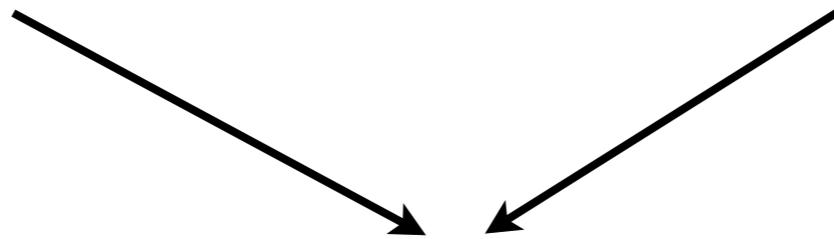
(Kavli Institute of Cosmological Physics, Chicago)

SM, 2011, arXiv:1107.1498 (ApJ, in press)

Galaxies as cosmological probes

Galaxies reside in dark matter halos.

Cosmological models **predict** the abundance and the clustering of halos.

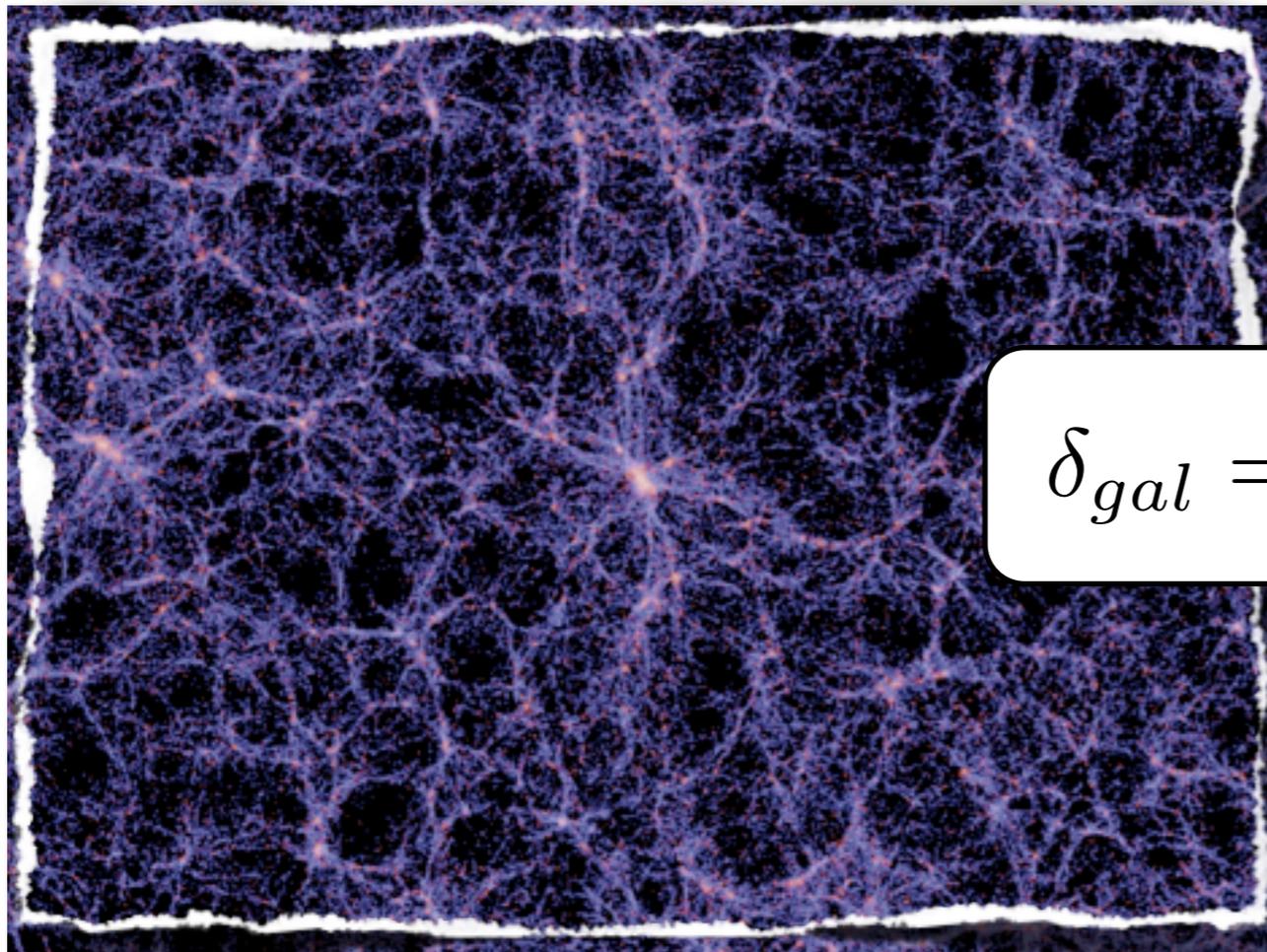


The abundance and clustering of galaxies (or groups of galaxies) can be used to constrain cosmological parameters*.

e.g., Tegmark et al. (2004), van den Bosch et al. (2007), Reid et al. (2010), Tinker et al. (2011) [list not at all exhaustive]

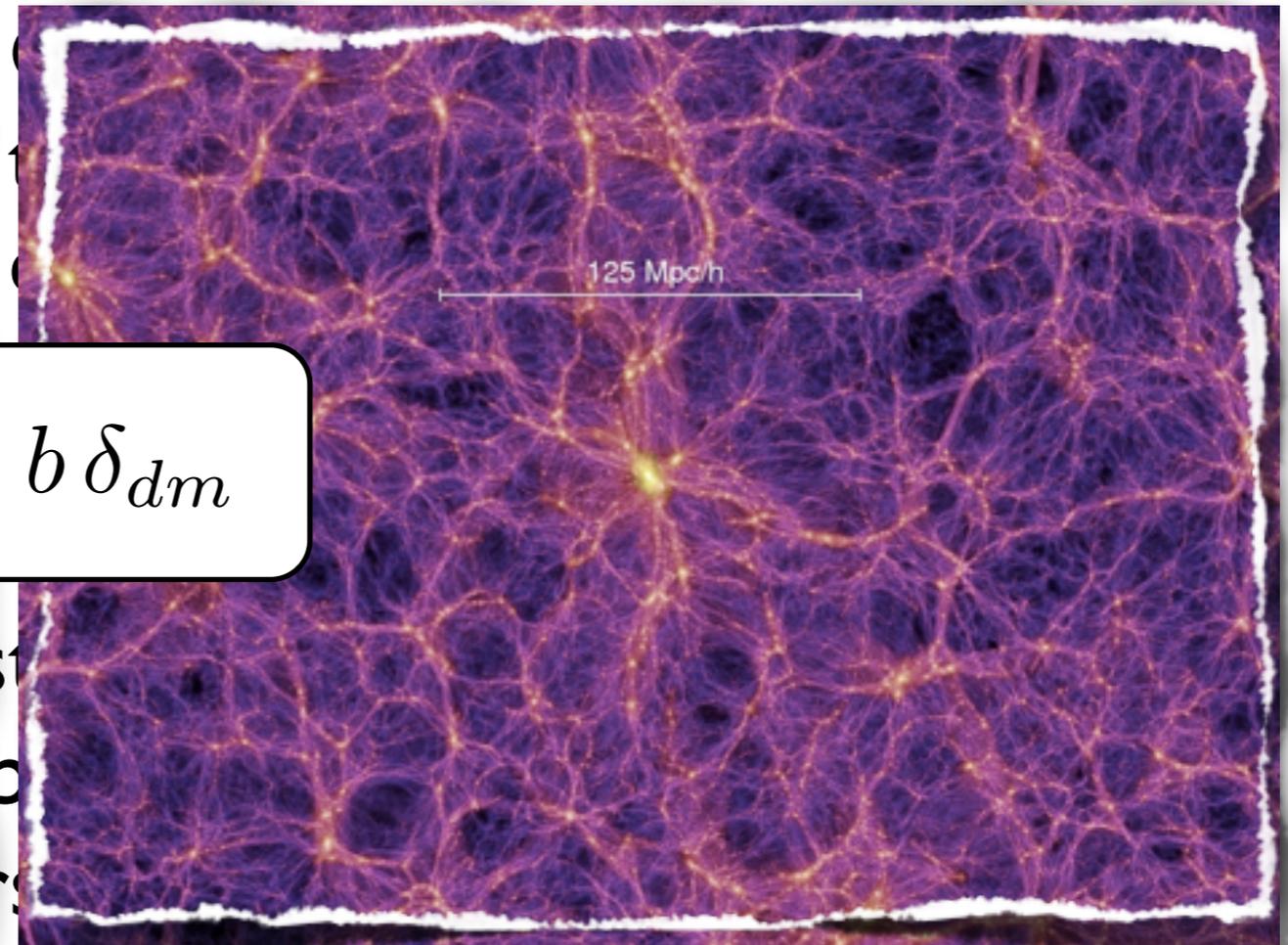
* Provided that you have an accurate mapping between galaxies and dark matter.

Galaxies as cosmological probes



Springel et al. 2005

Galaxies



Dark Matter

$$\delta_{gal} = b \delta_{dm}$$

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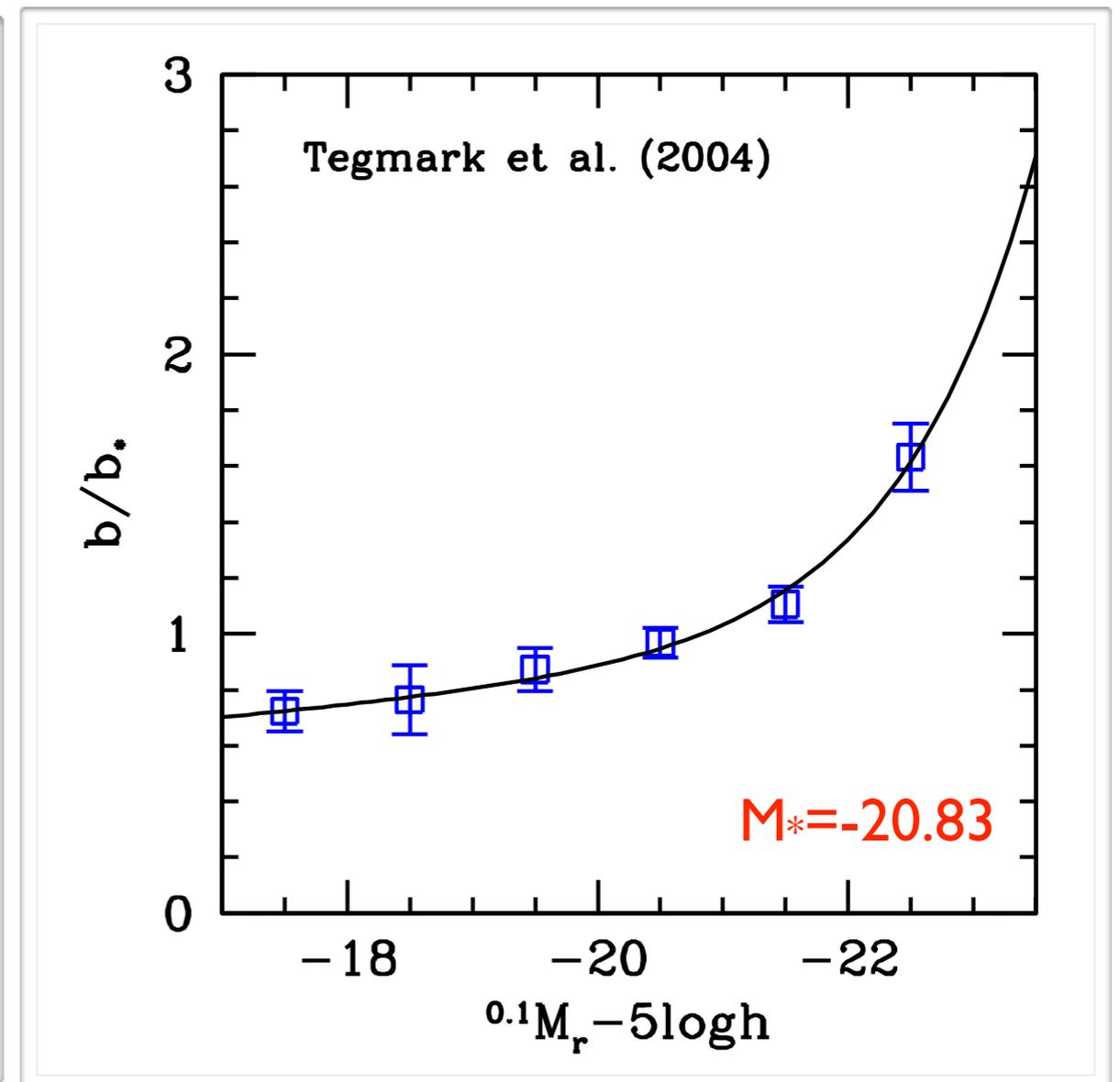
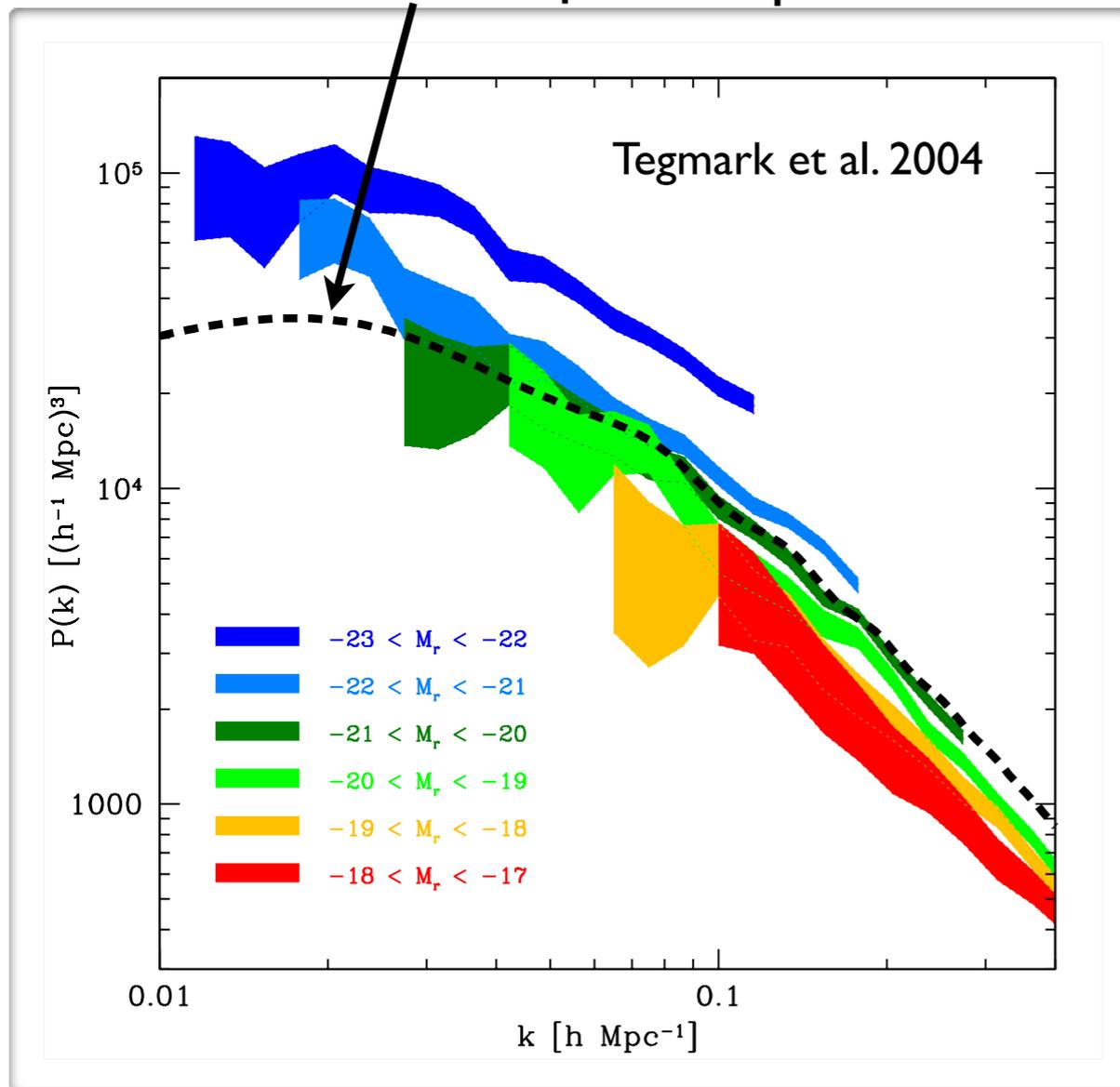
Galaxy bias- two approaches

- Large scale power spectrum measurements (scales larger than 60 Mpc), e.g. Tegmark et al. (2004), Percival et al. (2005)
 - PRO: Power spectrum is roughly linear, shape gives cosmological parameters
 - CON: Galaxy bias degenerate with σ_8 .
- Small scale clustering (scales smaller than 30 Mpc), e.g., Zehavi et al. (2005, 2010)
 - CON: Significantly non-linear, model using halo occupation distribution modeling.
 - PRO: Potential to remove degeneracy with σ_8 by combining with mass to light ratio observables. (see e.g. Seljak et al. 2005, Cacciato, van den Bosch, SM et al. 2009)

Compare the product of $b\sigma_8$ to test systematics!

Large scale power spectrum

Reference Λ CDM power spectrum



- Measure the power spectrum in luminosity bins and get the galaxy bias-luminosity relation.

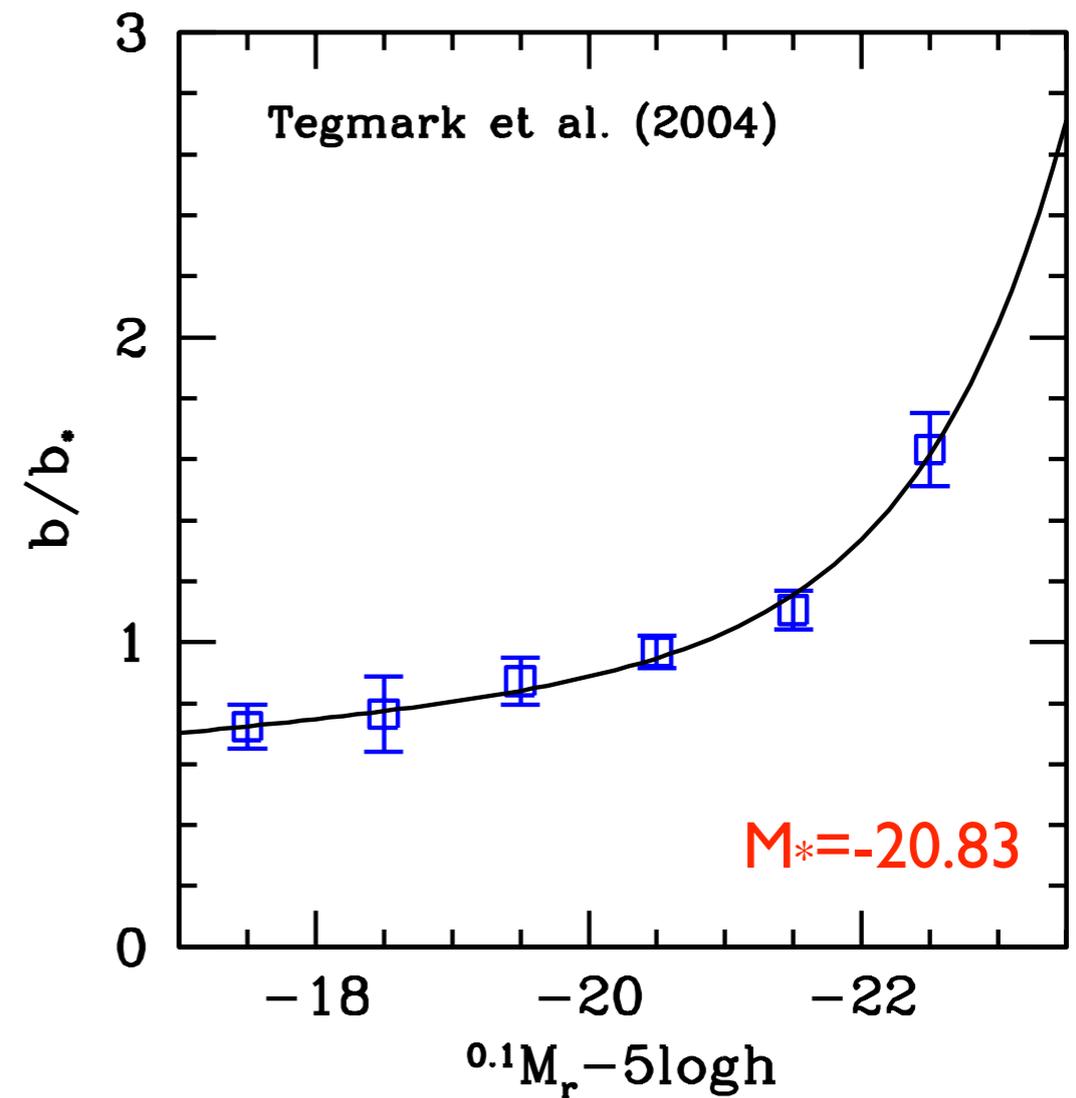
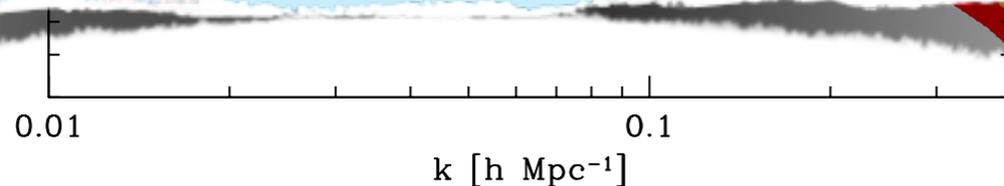
Large scale power spectrum

Reference Λ CDM power spectrum

$$\frac{b}{b_*} = 0.85 + 0.15 \frac{L}{L_*} - 0.04(M_r - M_*)$$

$$b_* \sigma_8 = 0.87 \pm 0.02$$

$$M_* = -20.83$$



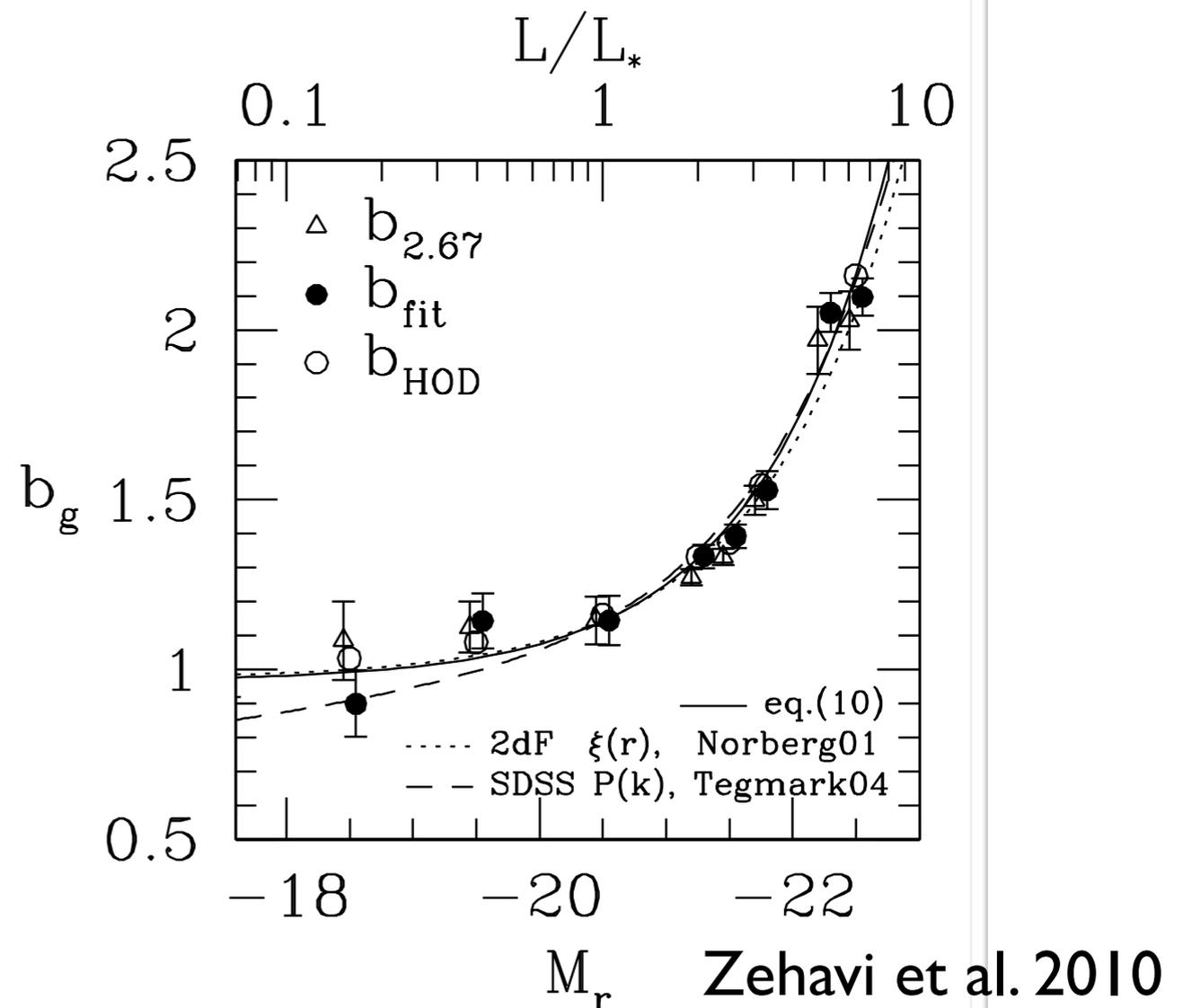
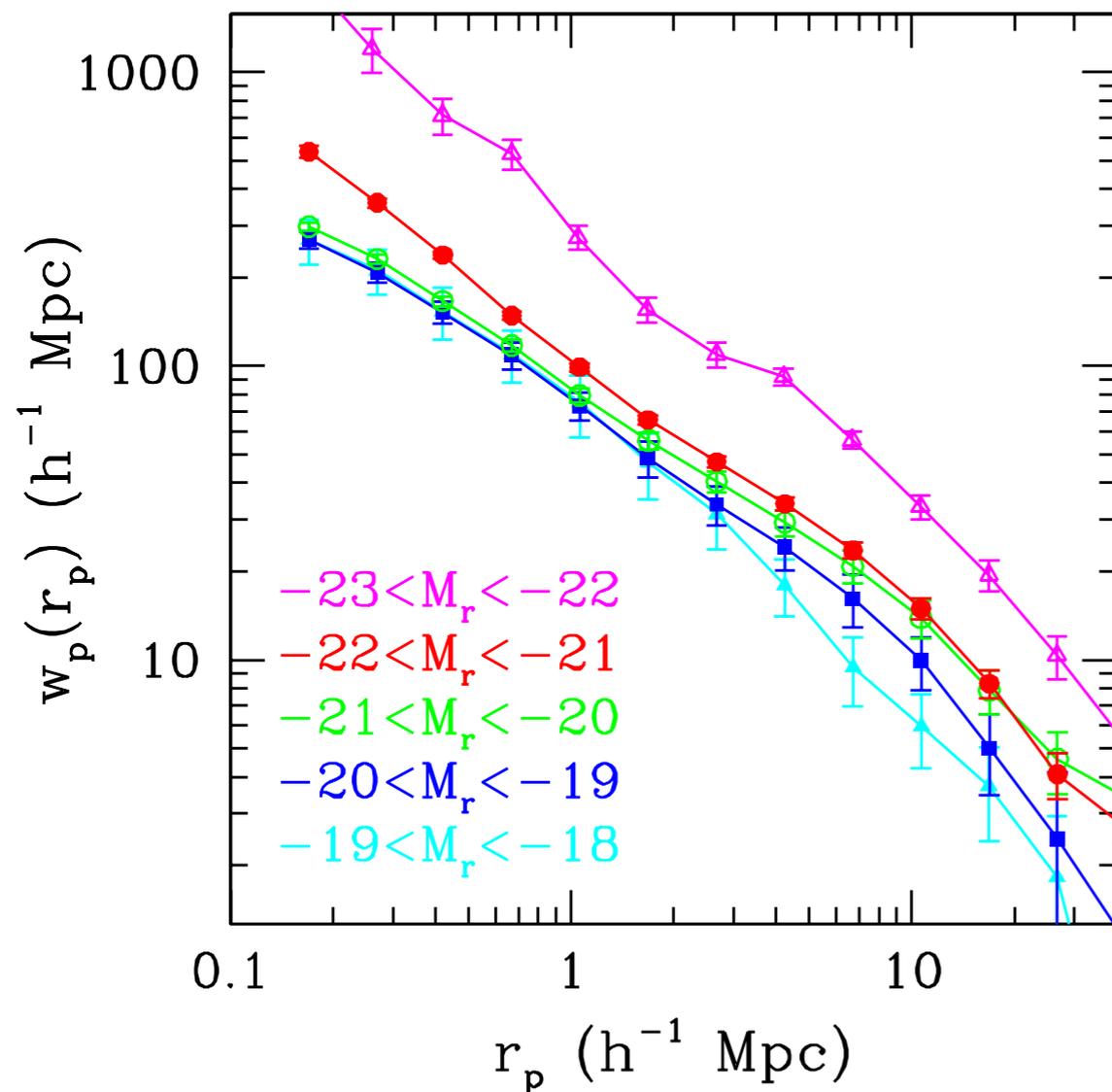
- Measure the power spectrum in luminosity bins and get the galaxy bias-luminosity relation.

Small scale clustering

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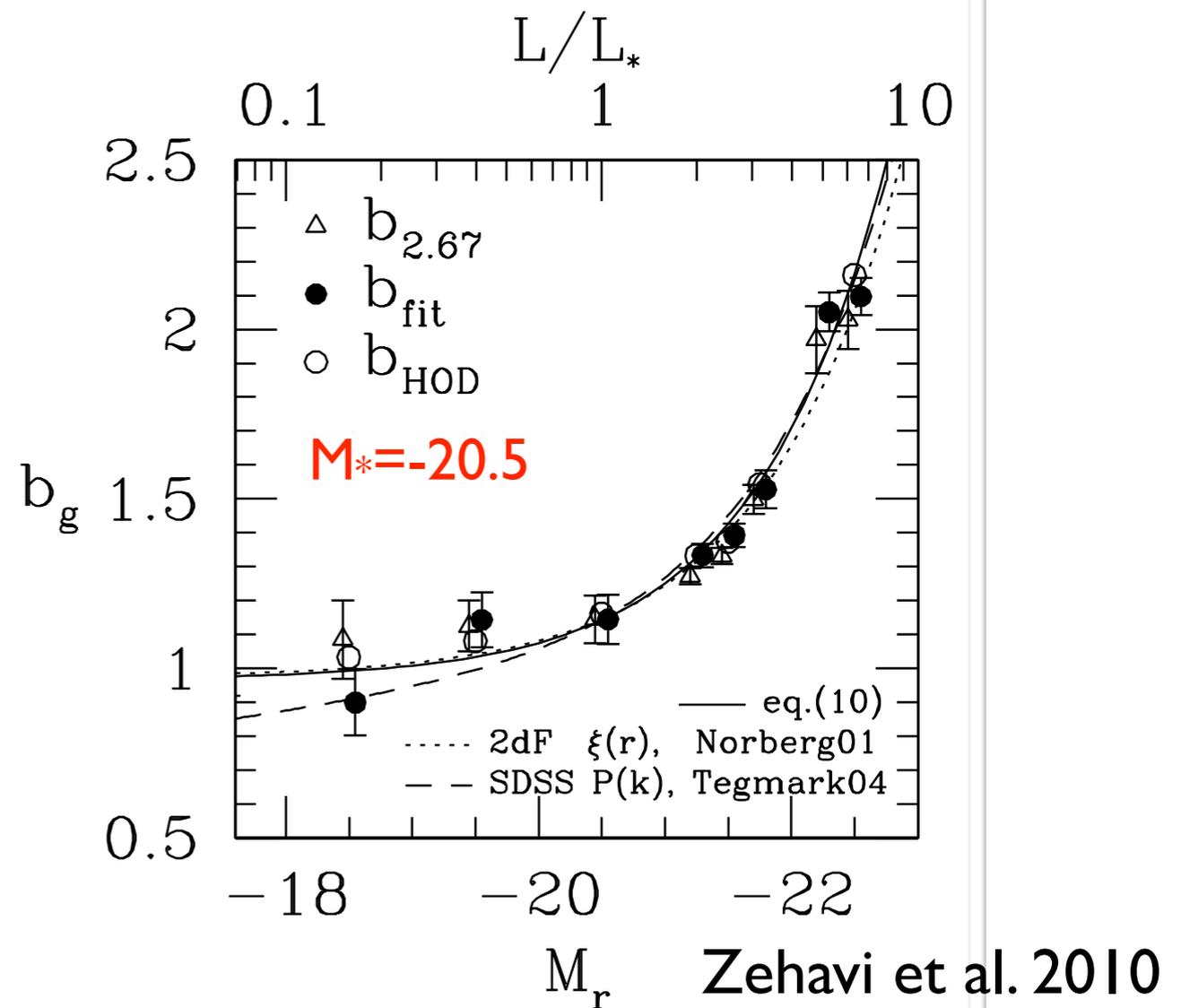
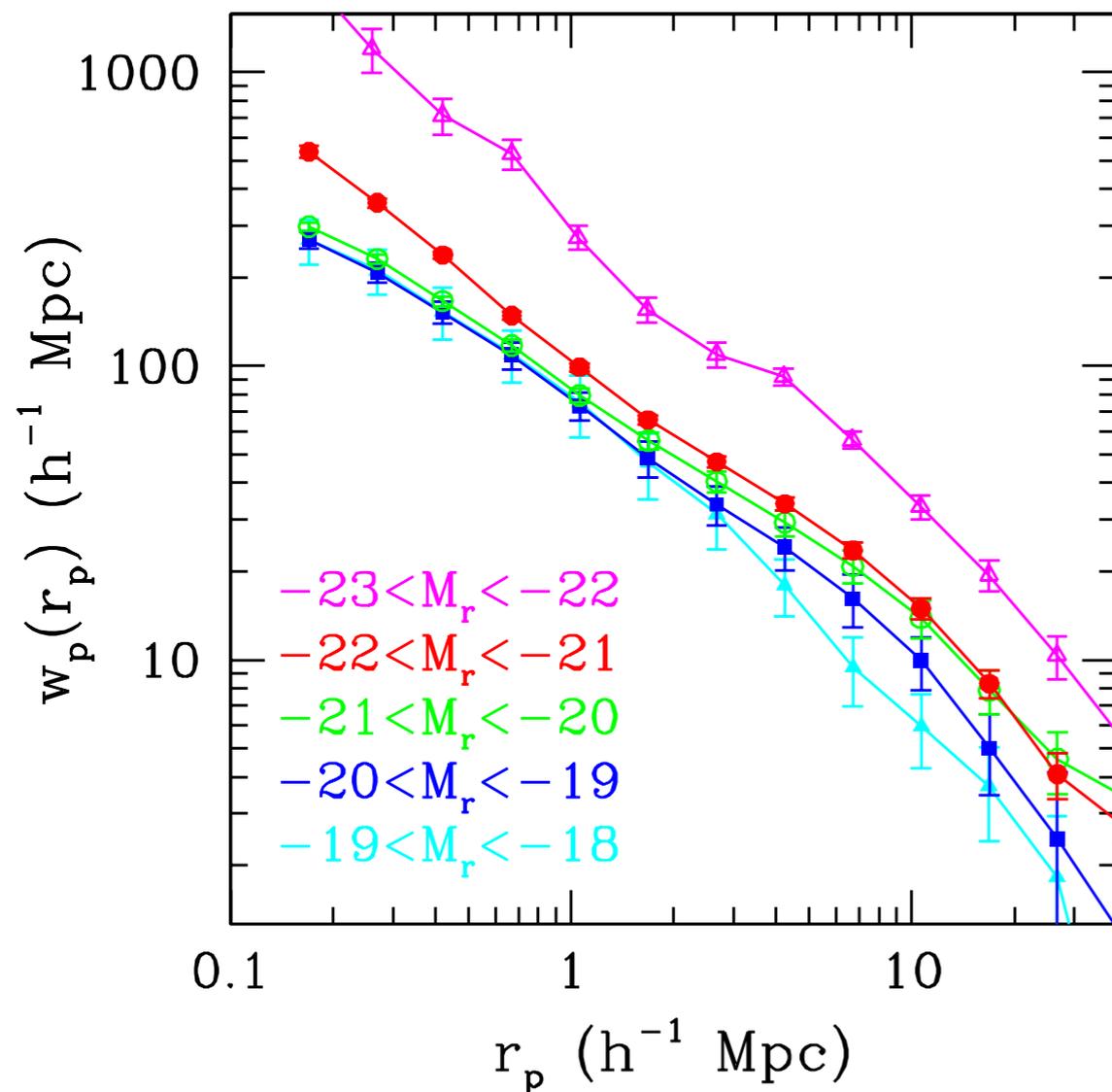
- Model small scale clustering of galaxies using the HOD model, and predict the large scale bias.

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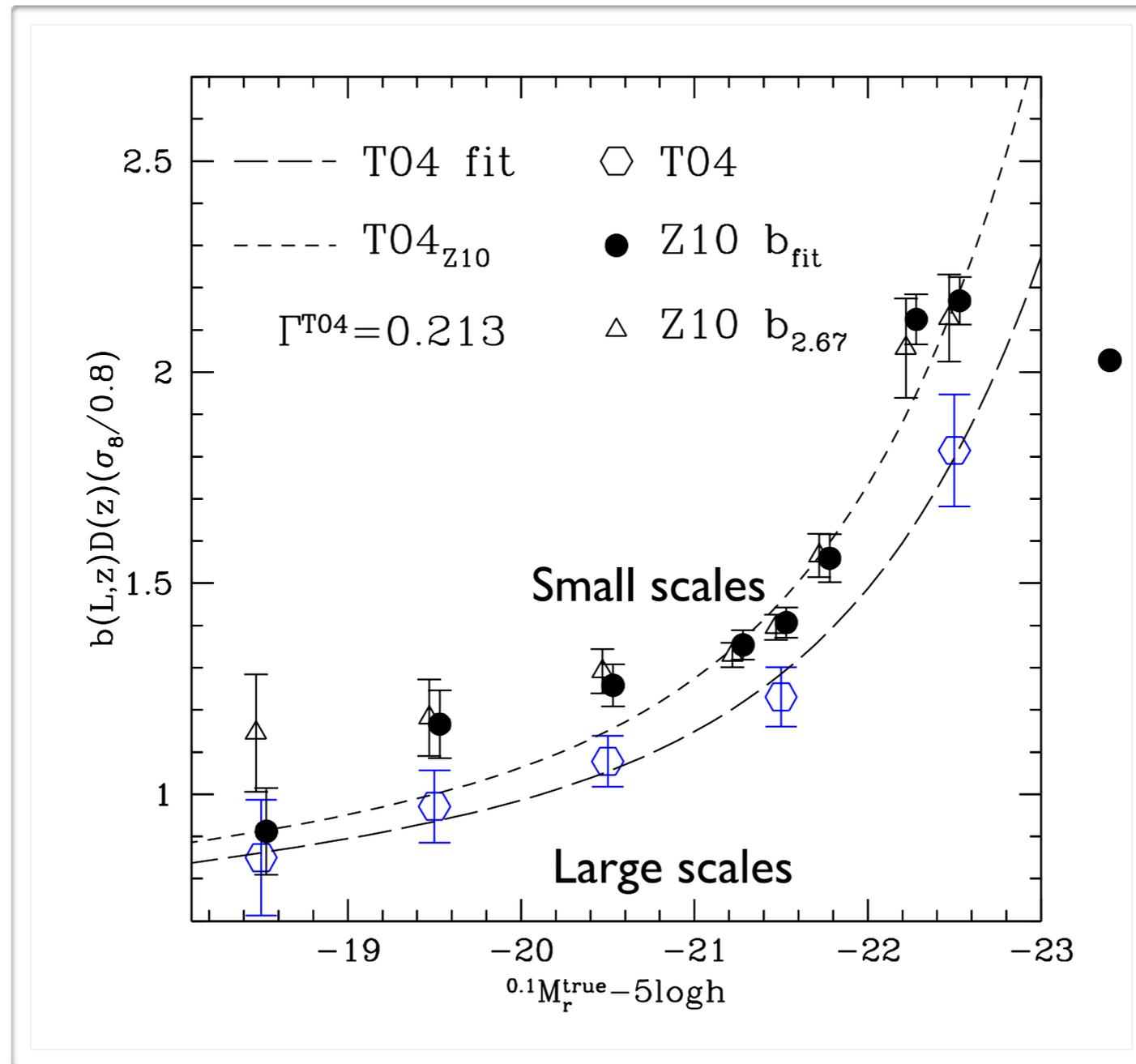
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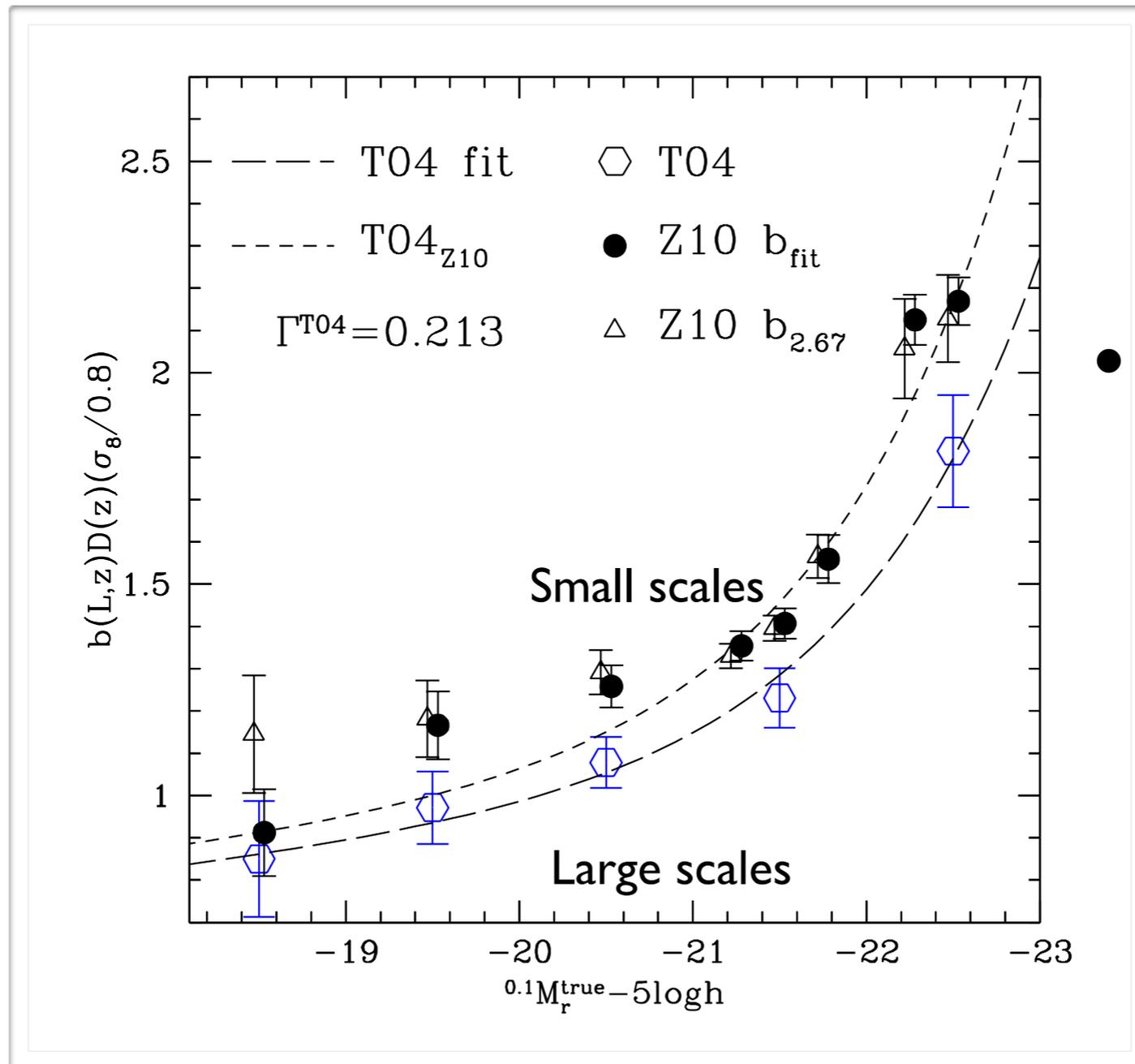
Houston, we have a **problem!**



- Clear **discrepancy** between results from small scales and large scales

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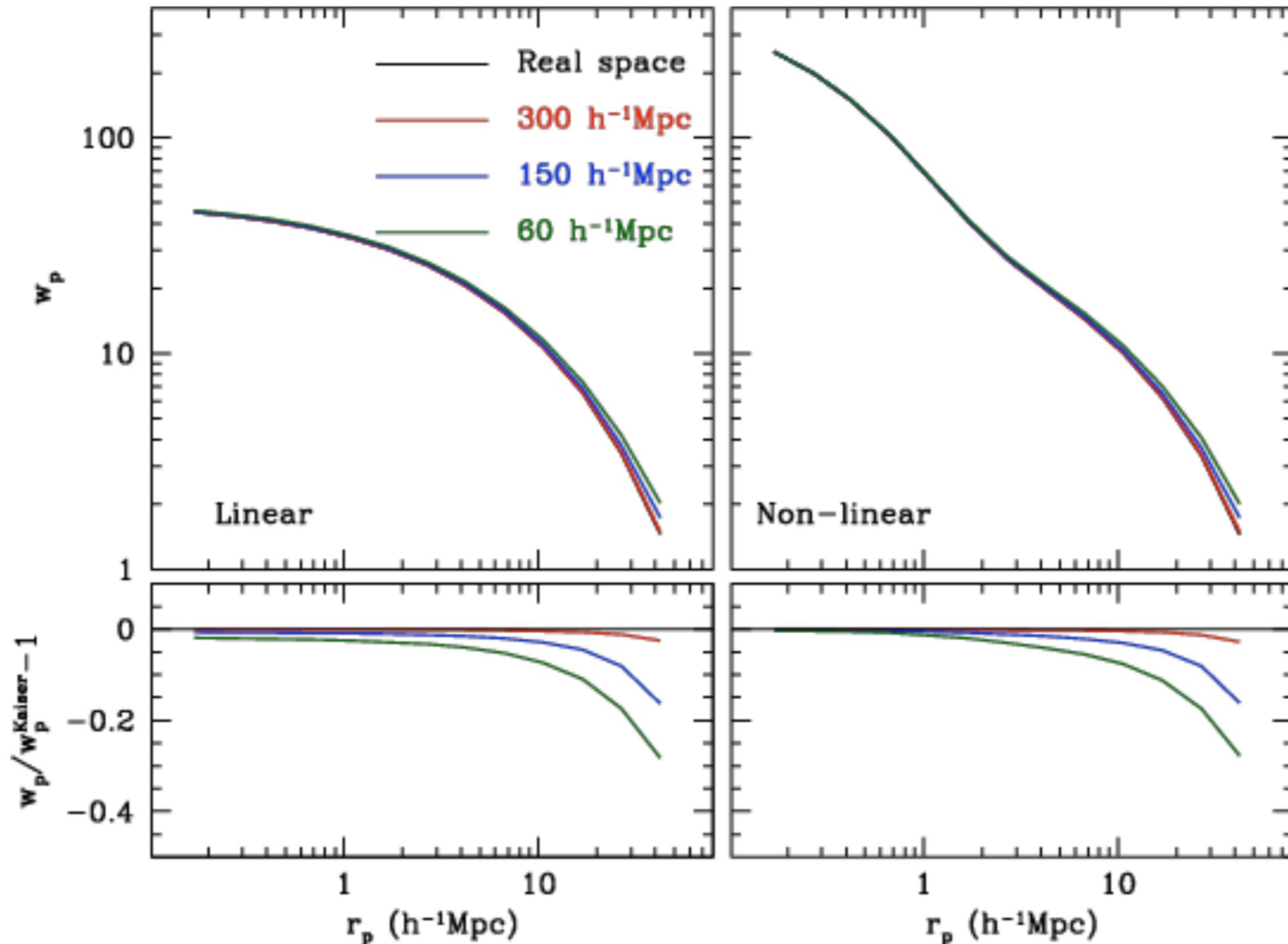
- Discrepancy remained unnoticed as the Tegmark et al. formula was used with $M_* = -20.5$ instead of -20.83 . The normalization b_* was never used in the previous comparison!

Possible reasons!

- Large scale measurements (Tegmark et al. 2004):
 - Problems in correcting for the redshift space distortions in the Tegmark et al. prescription
 - Quasi-linear effects
- Small scale measurements (Zehavi et al. 2010)
 - HOD model may not be accurate enough
 - Residual redshift space distortions

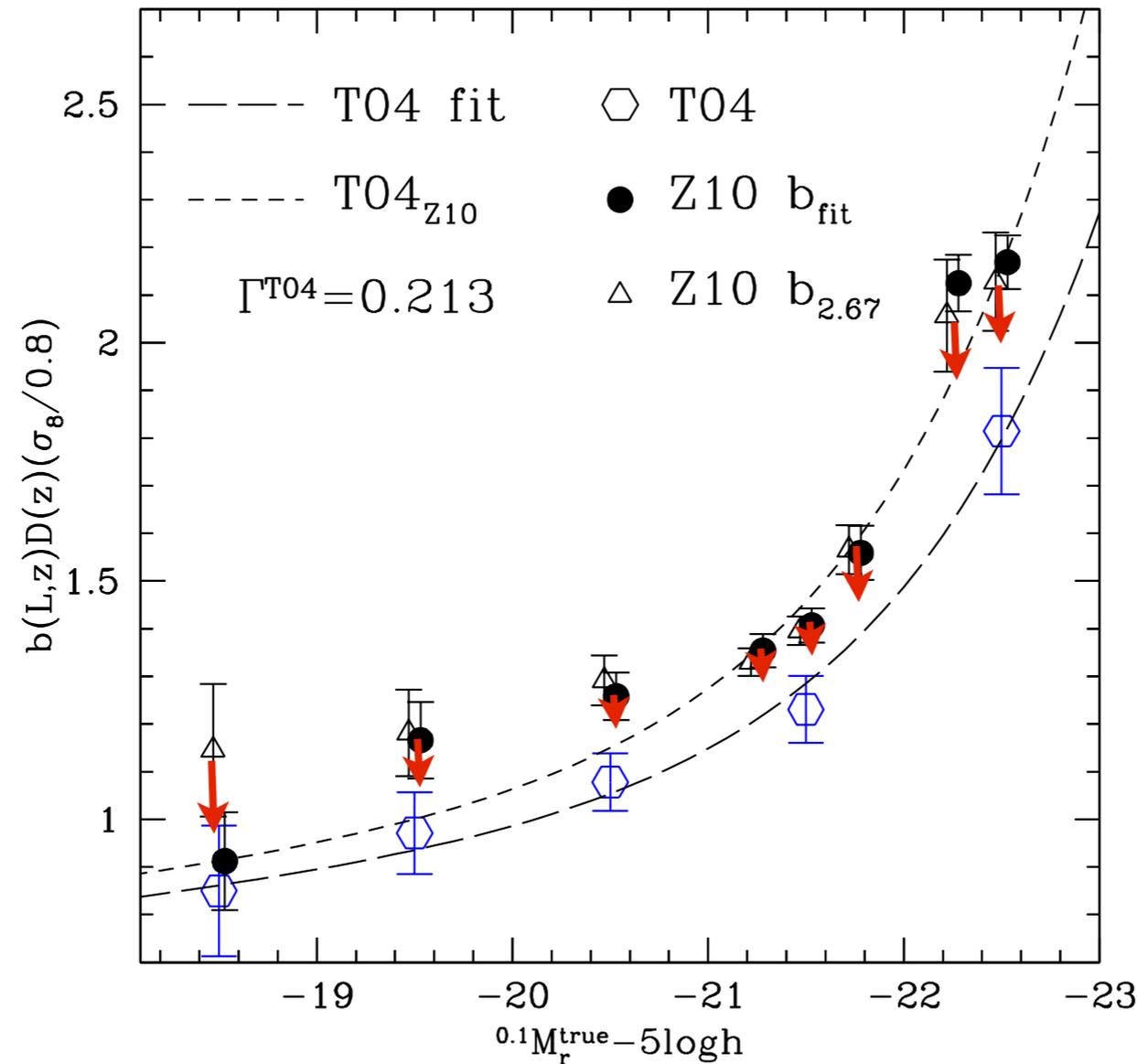
Residual redshift space effects

See also: Norberg et al. (2009)



- Finite integration limit to get the projected correlation function

Using the Kaiser correction!



- Moves down the Zehavi et al. (2010) points by $1-\sigma$, but not enough to fully resolve the discrepancy!

Conclusions

- **Discrepancy** between the large scale **galaxy bias-luminosity** relation obtained from the **large scale** power spectrum and the **small scale** clustering measurements.
- The power spectrum presented by Tegmark et al. 2004 is **not** for **L^*** galaxies but for **$1.45 L^*$** galaxies.
- Implications:
 - Wrong $b(L)$ relation can cause the **cosmological parameters** from the power spectrum of flux-limited samples to be **biased**.
 - HOD modeling certainly needs to account for **finite π_{\max}** !

Thank you!