There is

(probably) **NO** (significant)

void problem

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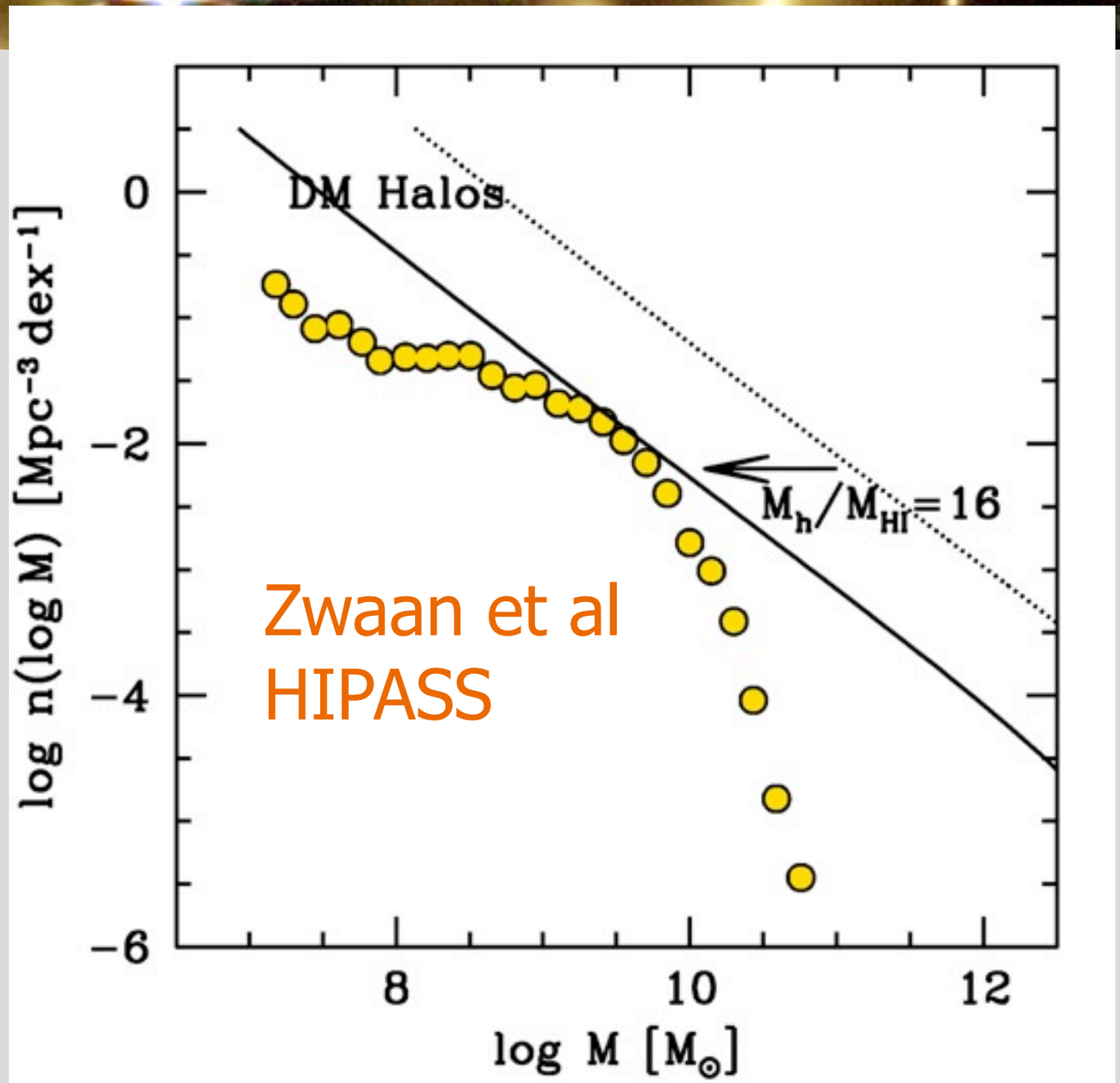
"LCDM predicts that..."

- Beware anyone (myself included) who starts a sentence with that phrase.
- No complete theory of galaxy formation:
  - Star formation not fully understood.
  - What is the role of quasars?
- LCDM predicts the distribution of dark matter: the halos. We can make an educated guess at what galaxies form and grow within them.

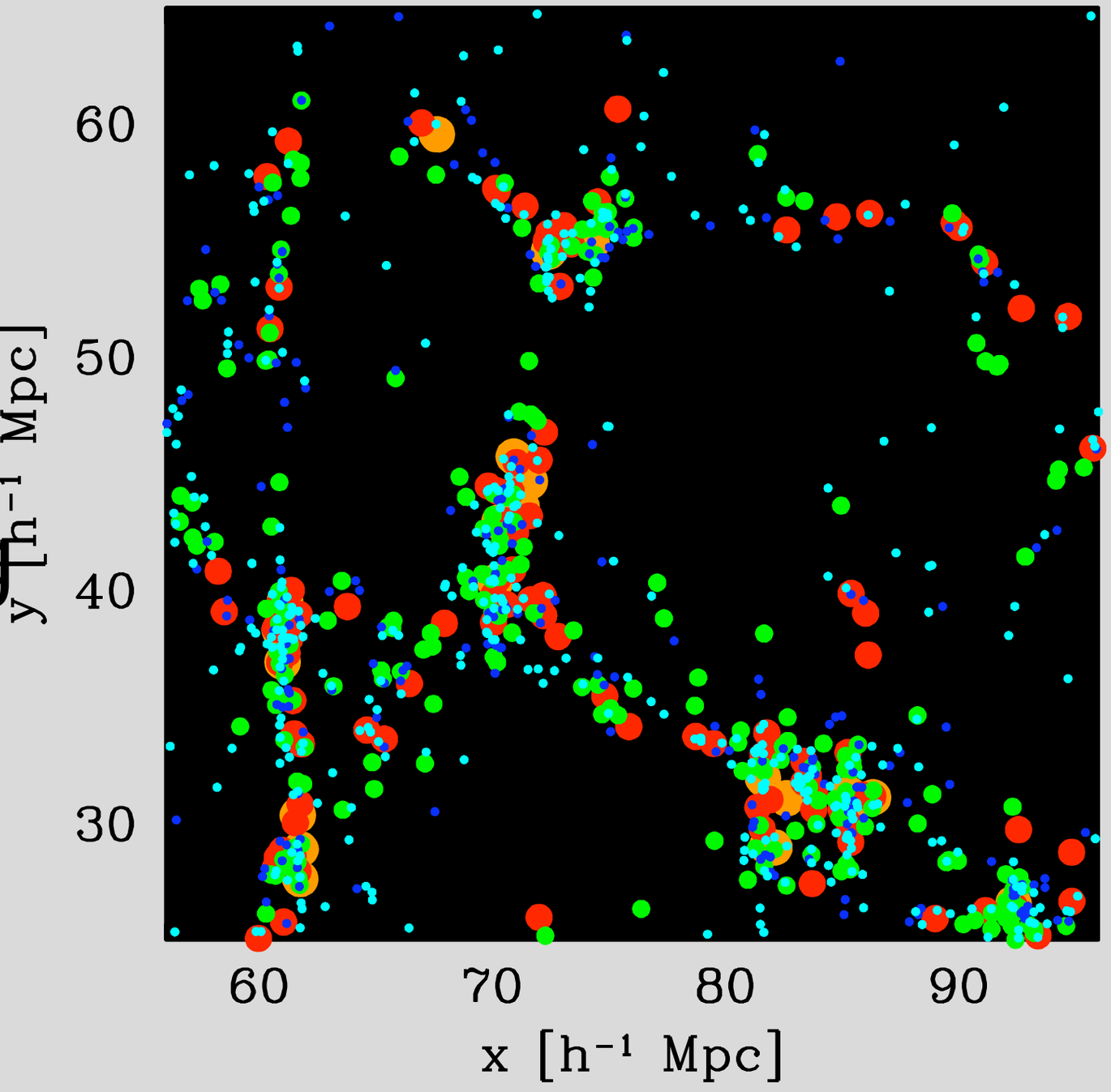
Pedagogical Example: HI Mass Function

- Galaxy formation suppressed at high/low masses (old problem).
- Constant HI/DM <u>does</u> predict too many HI galaxies in voids...
- Also predicts too many HI galaxies <u>everywhere</u>: nothing to do with voids.



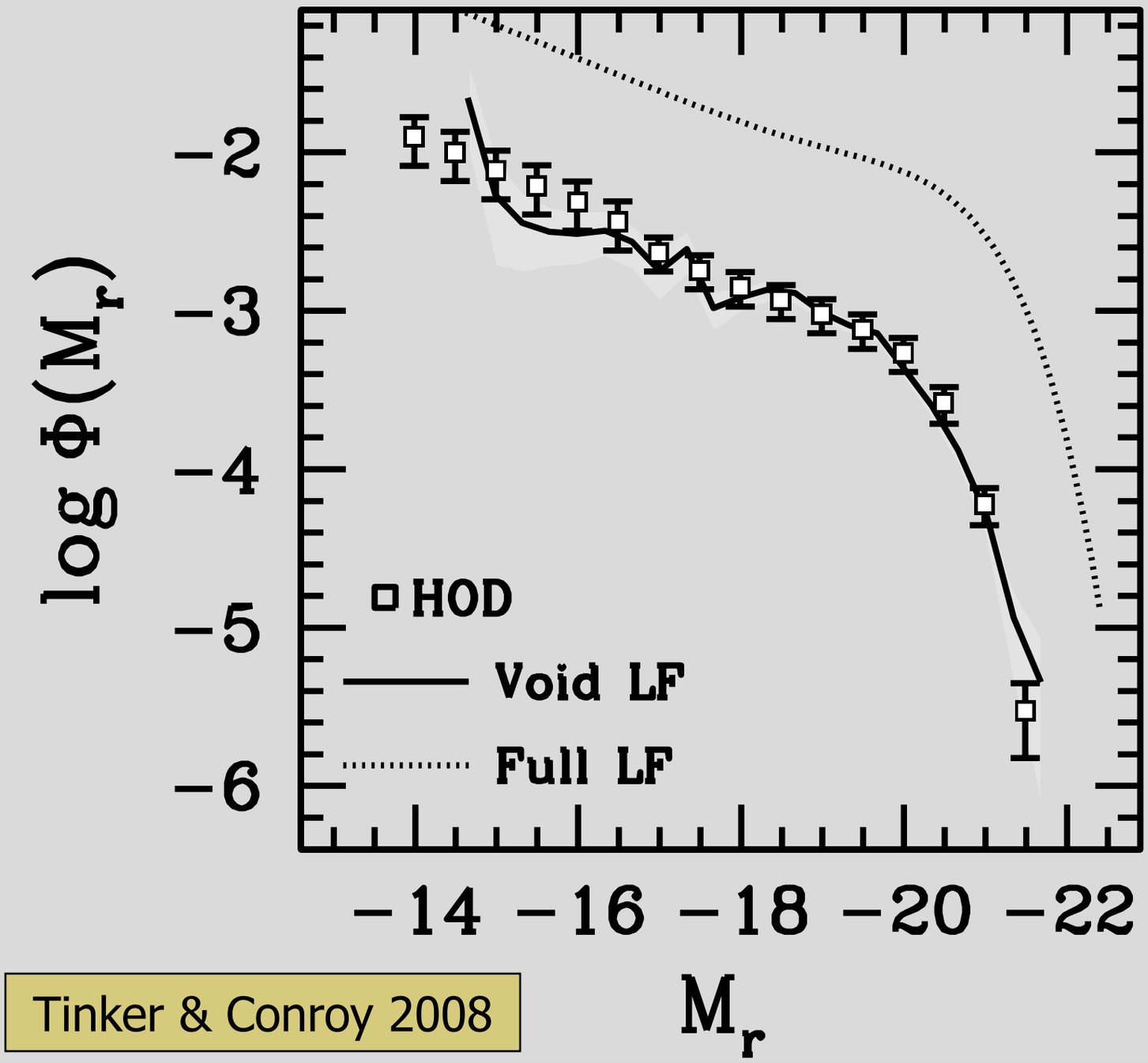
Accounting for galaxy bias

- Set up galaxy bias to match $\Phi(L)$ and $\xi(r,L)$.
- Assume that this galaxy-halo matching is the same at all densities.
- What do the voids look like at Mr~-12?



Void Luminosity Function

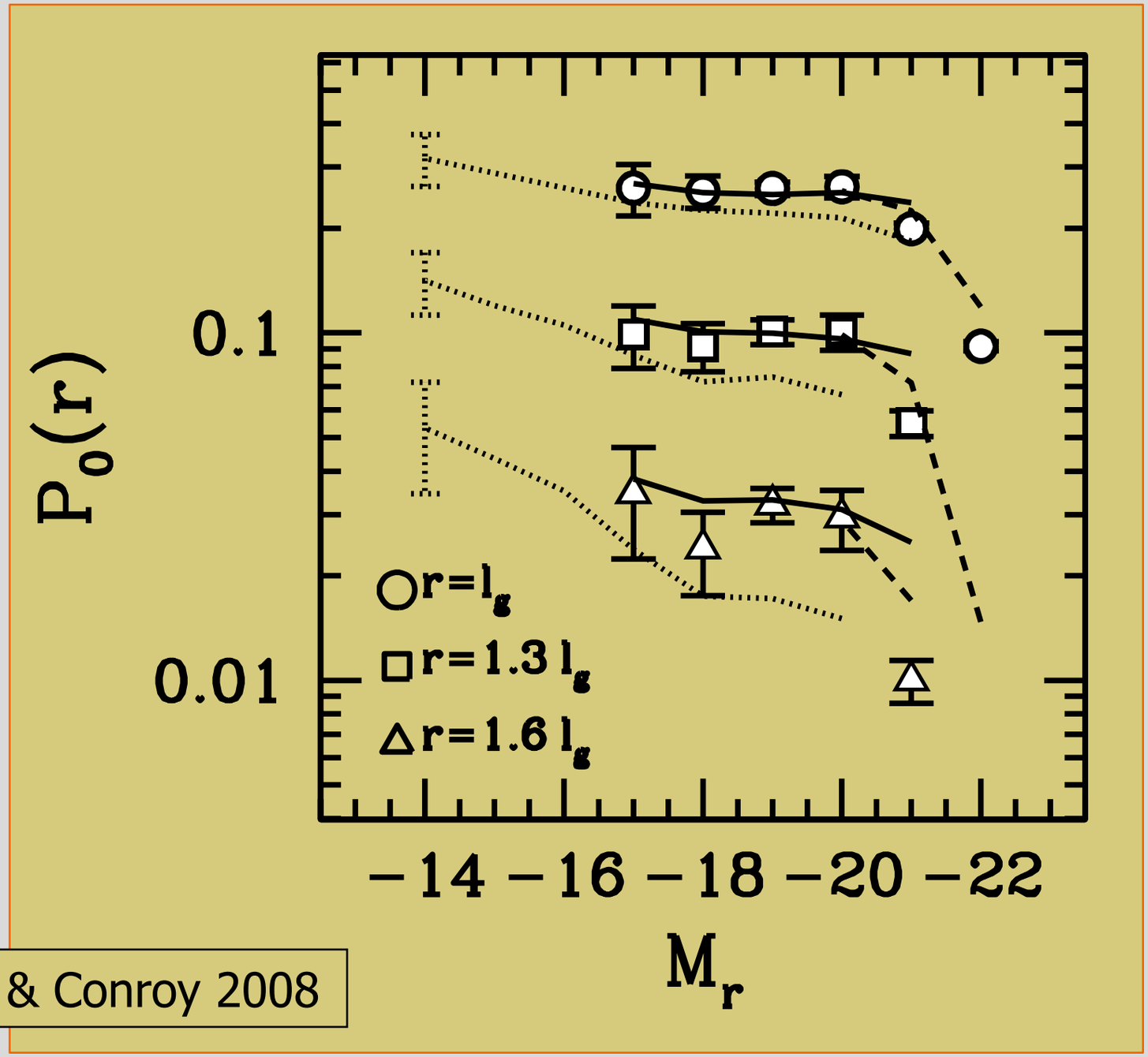
- Solid Curve: Hoyle et al 2005, SDSS.
- Points: Model prediction.
- Also fits density-dependent Φ(L) from 2dFGRS (Croton et al 2005)



Tinker & Conroy 2008

Void Probability Functions

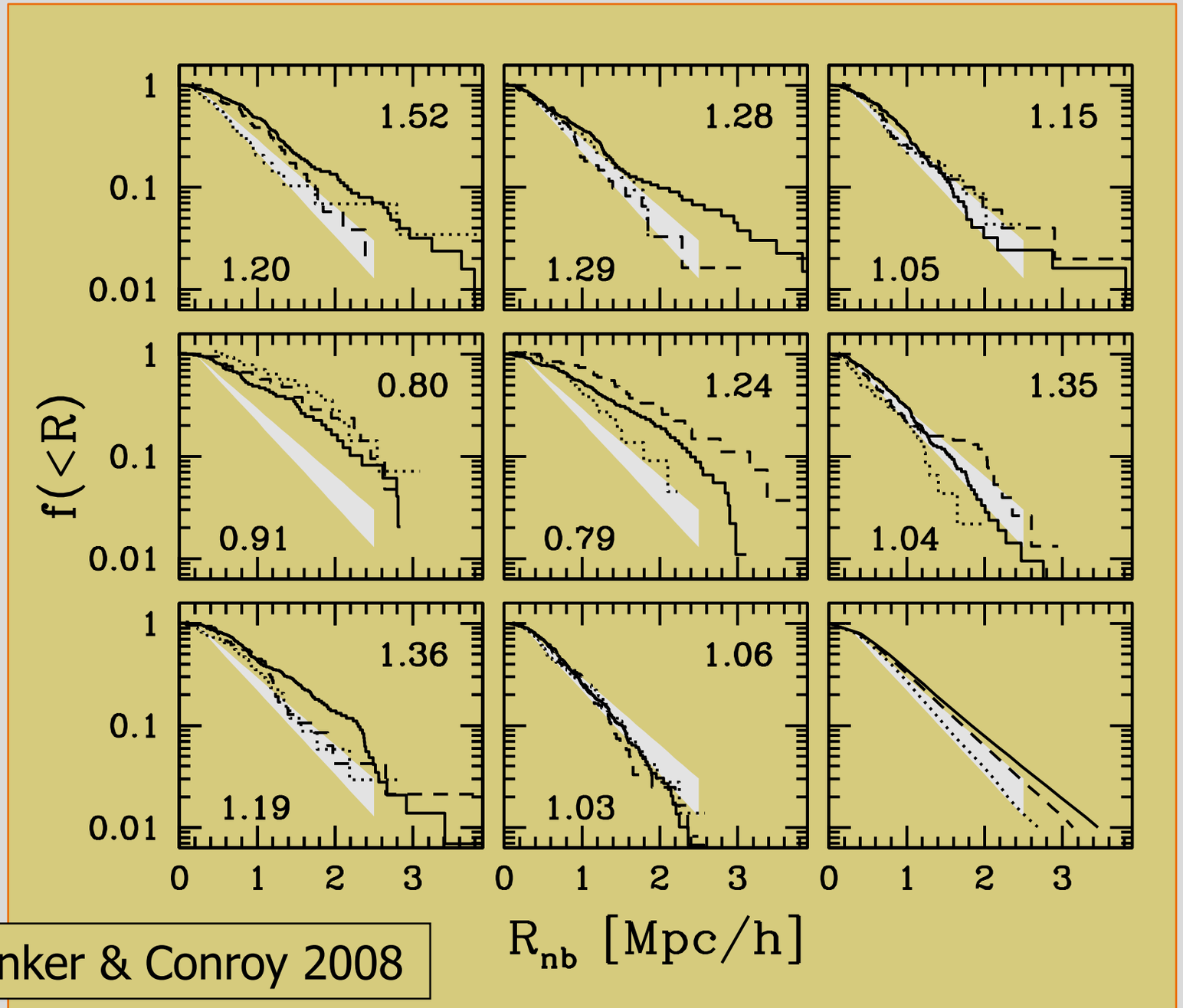
- SDSS DR6 data: VPF at 3 values of mean galaxy separation.
- Lines: Model results from 3 different N-body simulations (with sample variance shown).



Tinker & Conroy 2008

Nearest-Neighbor Statistics

- Shaded region: Peebles (2001) measurements for "dwarf" and "regular" gals.
- Curves: Model predictions for Mr~-15 galaxies (dotted), Mr~-17 galaxies (dashded), Mr<-18 galaxies (solid)
- Panels: multiple volumes equal to Peebles' sample.
- Conclusion: sample variance very large, but on average very weak dependence on galaxy luminosity.



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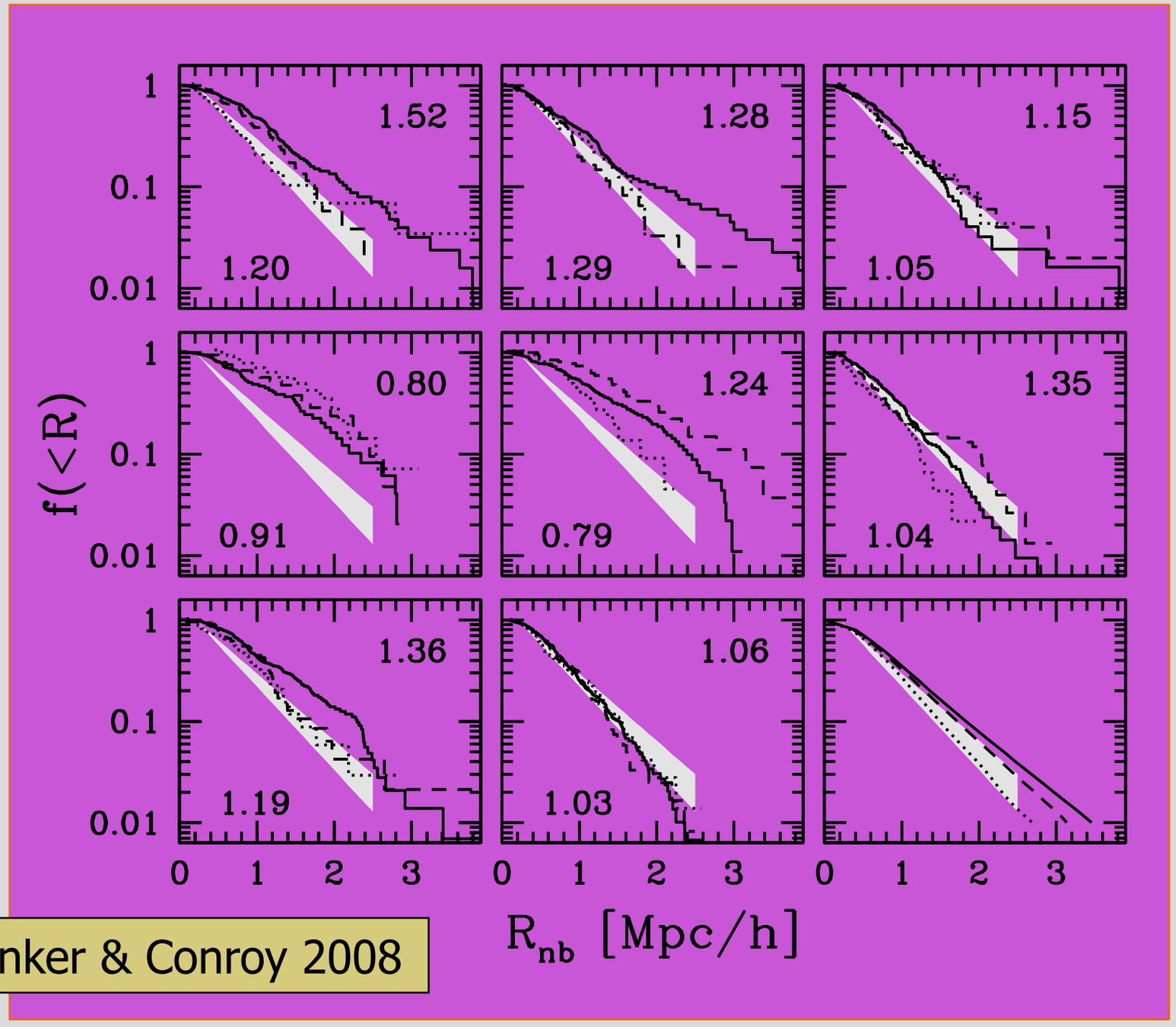
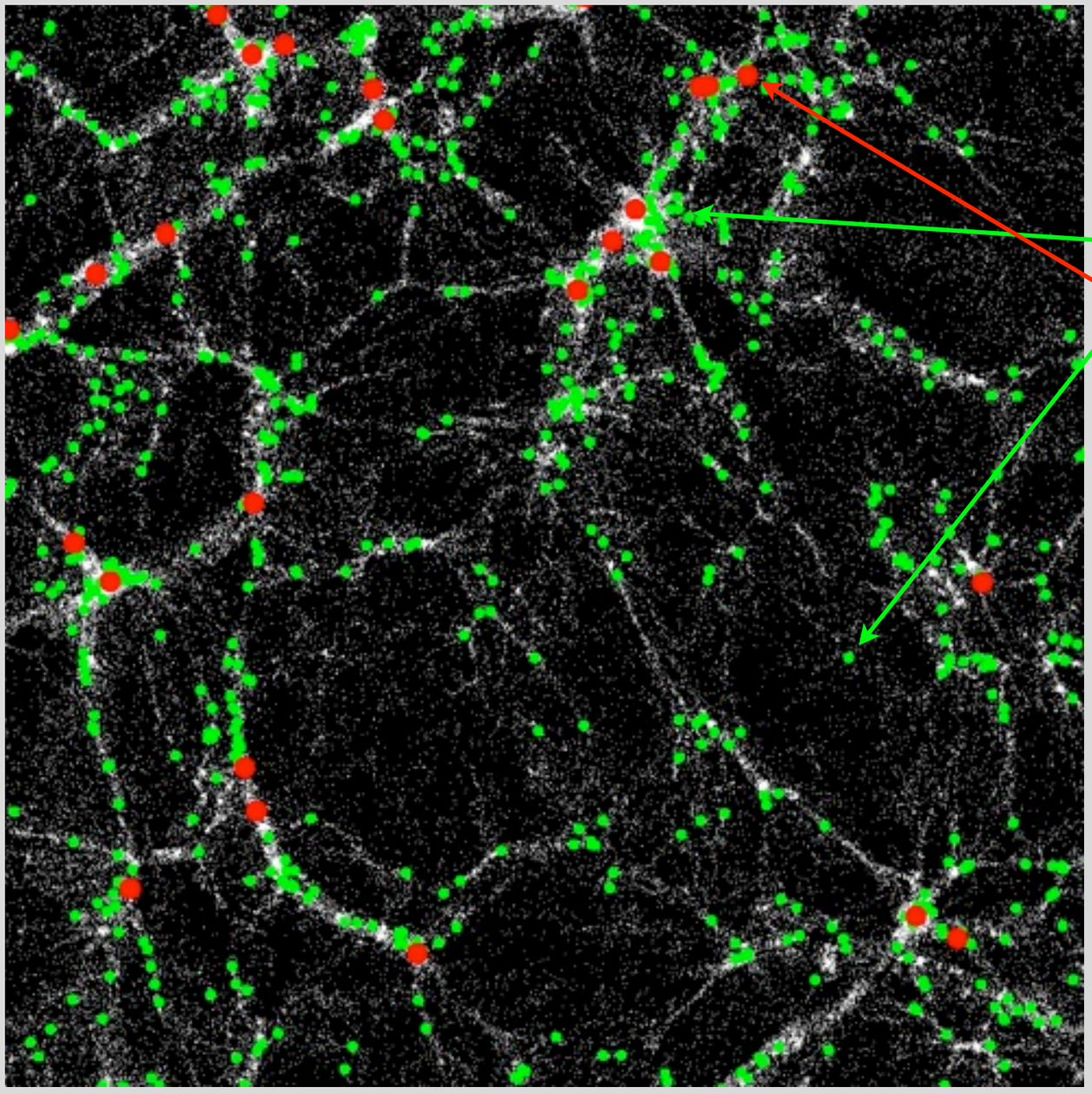


Tinker & Conroy 2008

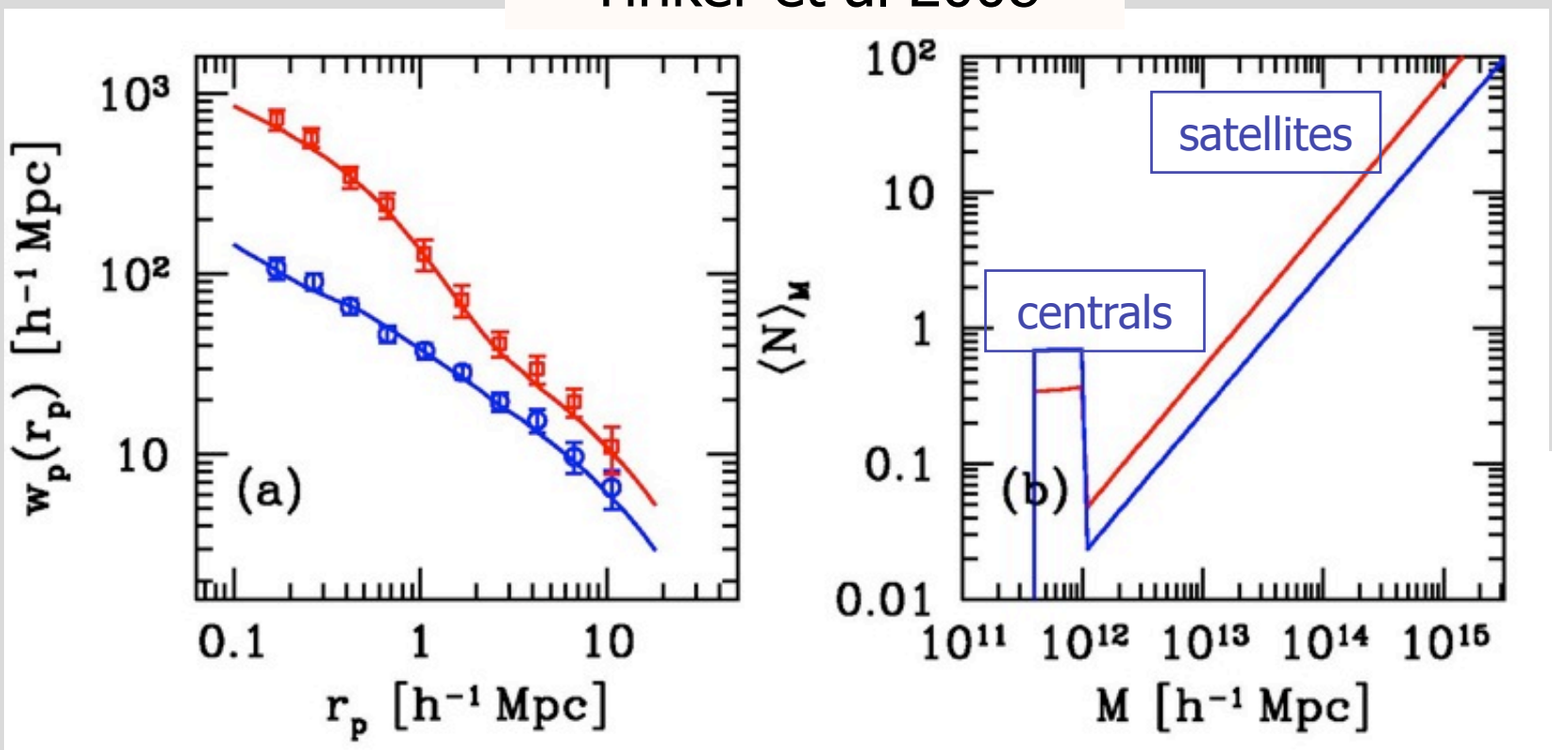
Voids in Color-Defined Samples



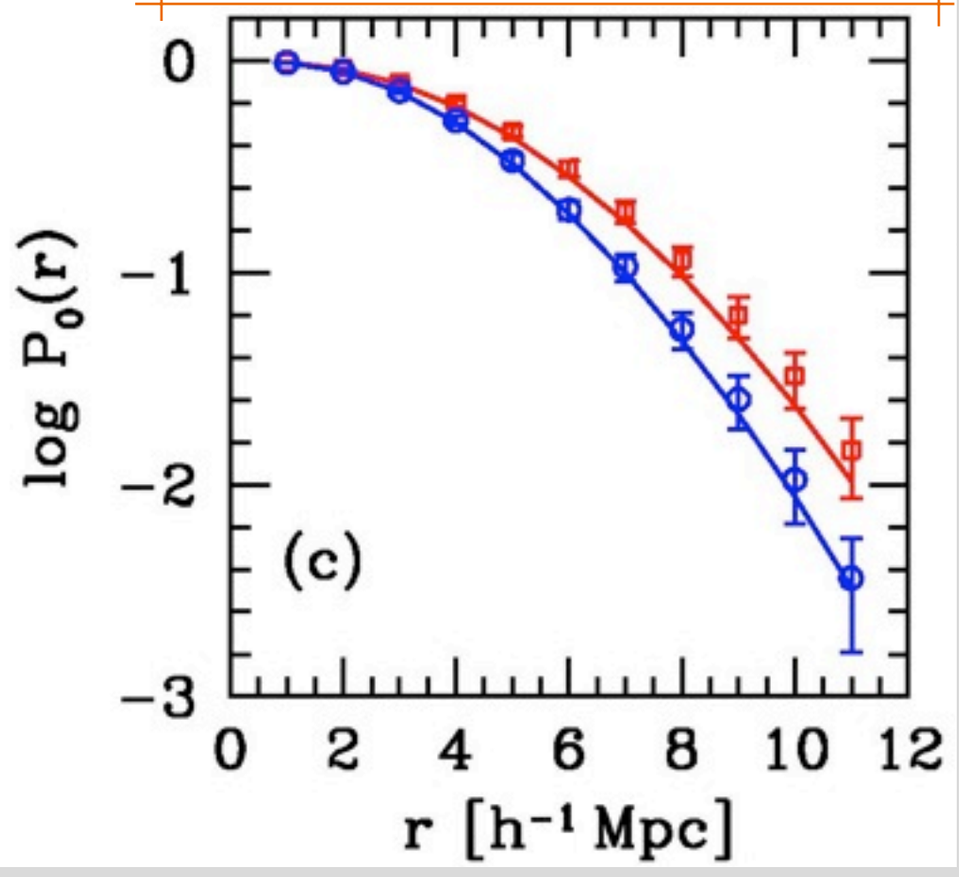
- At fixed L, 2 types of "halo occupancy": central in low-M halos, satellites in high-M halos.
- low-M halos span all densities.
- model: probability of central red independent of environment?
- Test: match ξ(r) and VPF at same time?

Voids in Color-Defined Samples

Tinker et al 2008



Predicted VPF for red/blue samples: color independent of environment at **fixed halo mass**

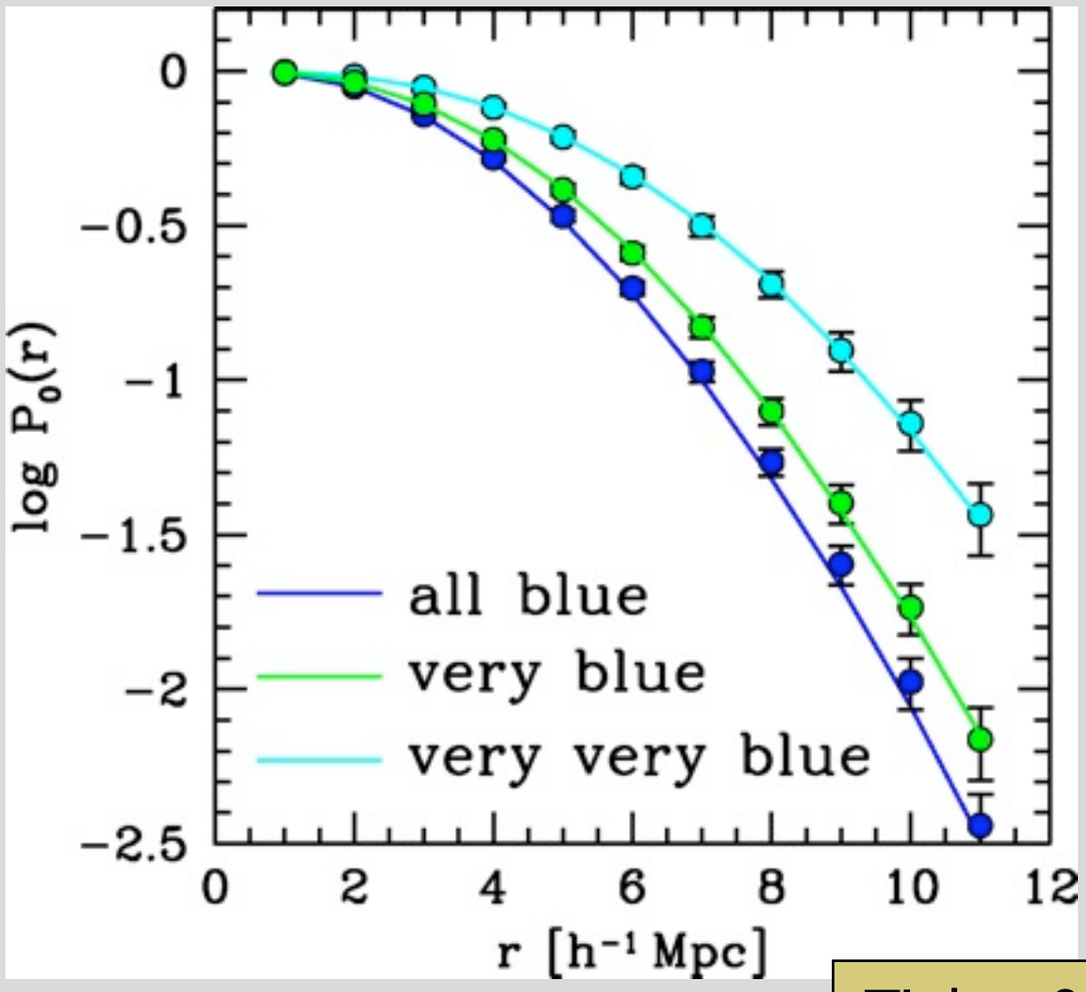


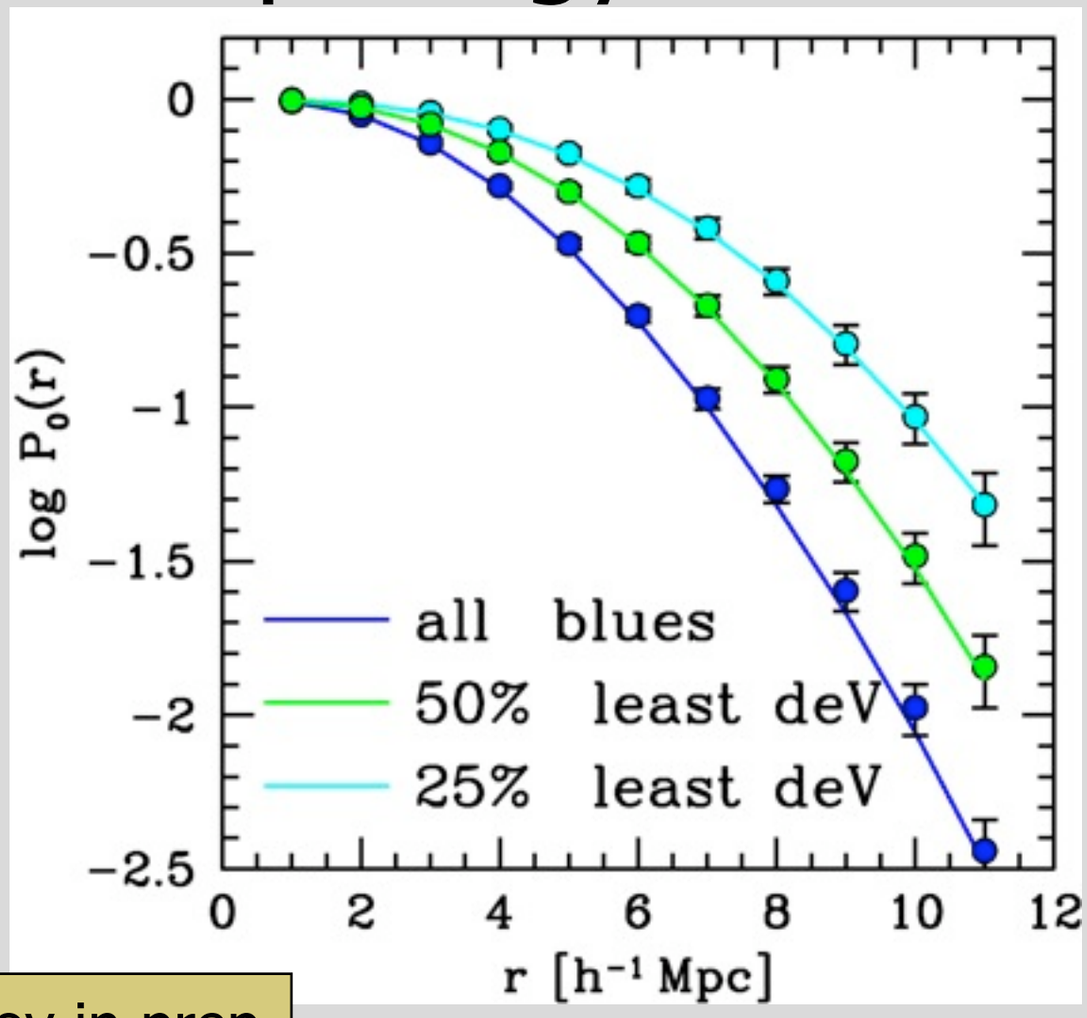
Correlation function for -18<Mr<-19 galaxies. (SDSS DR4)

Halo occupation derived for red/blue galaxies.

Voids in Color-Defined Samples

- Same result when breaking the blue sample up by color or morphology

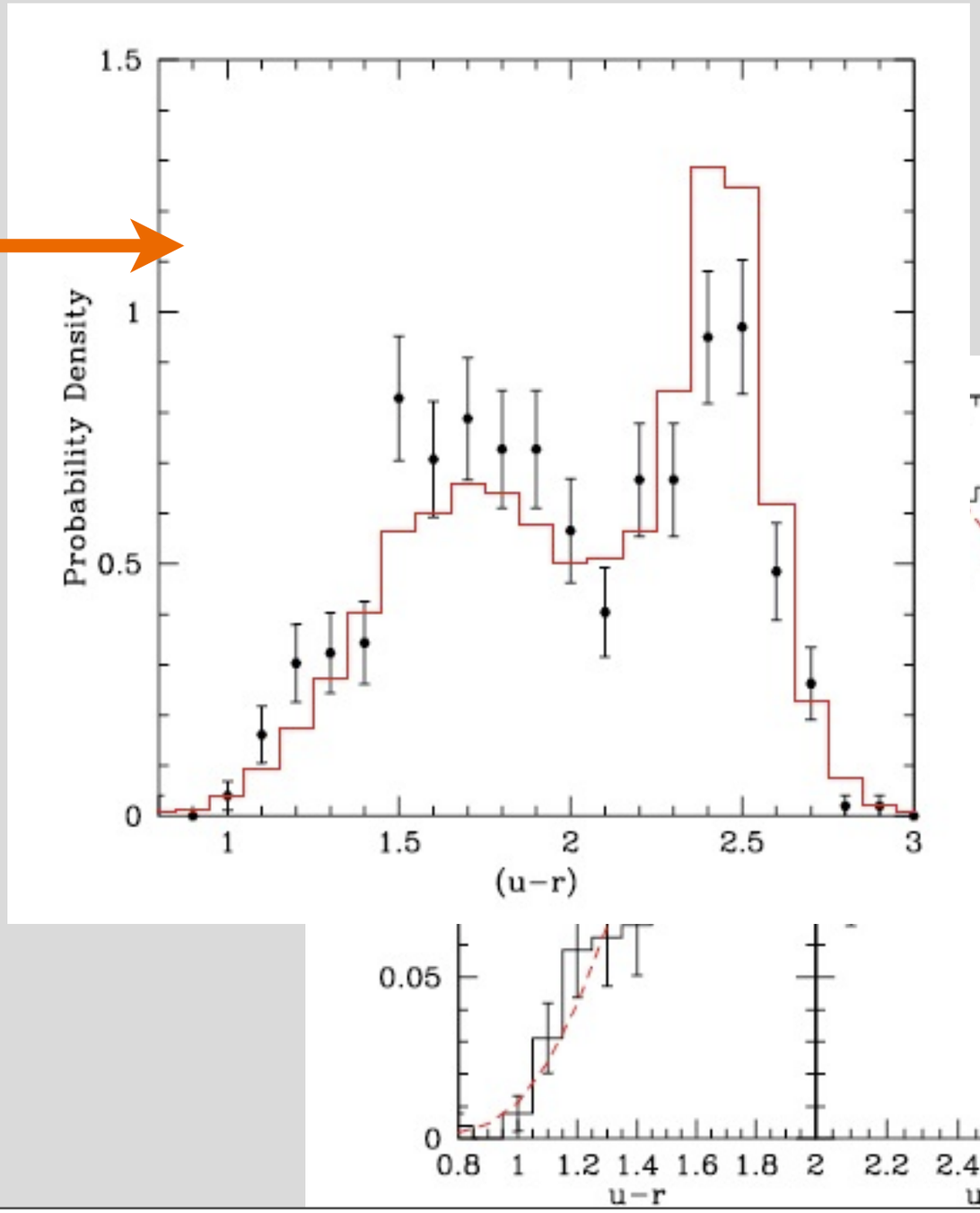




Tinker & Conroy in prep

Voids in Color-Defined Samples

- Consistent with observational results from Patiri et al (2006).
- Agrees with conclusions from SA models (Croton & Farrar 2008) for higher-mass systems.



Conclusions

- Voids are as wide and deep as they "should be" in LCDM+galaxy bias.
- But, as questions become more detailed, the details will matter more.
- Gross properties of galaxies are essentially determined by host halo mass, and environment is a distant "second parameter".