The Effects of Galaxy Assembly Bias on the Inference of Growth Rate from Redshift-Space Distortions

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Growth Rate of Large-Scale Structure

Why? • Test theories of gravity. • Constrain Dark Energy.

Growth Rate Factor: How quickly are f =matter fluctuations growing?

Matter Fluctuation Amplitude Normalization: Fluctuations in spheres with radius 8 h⁻¹Mpc.



Growth Rate of Large-Scale Structure

How?

- Measure the galaxy-galaxy two point correlation function (2PCF) in redshiftspace.
- Deviations from spherical due to peculiar motion of galaxies relative to expanding space probe dark matter velocity field.

Redshift-Space Distortions (RSD)



Growth Rate of Large-Scale Structure

Amplitude of galaxy-galaxy 2PCF —> $b_g \sigma_8$ Shape of galaxy-galaxy 2PCF —> $\beta = \frac{f}{b_a}$



<u>s > ~30 h⁻¹Mpc</u>

Galaxy bias is constantLower statistical power

Growth Rate inference relatively easy.

<u>s < ~30 h⁻¹Mpc</u>

Galaxy bias is not constantHigher statistical power

Growth Rate inference a bit more complicated.

Investigation of Potential Systematic

Potential Systematic?

Halos cluster according to assembly history.

If galaxy properties depend on halo assembly history— Galaxy Assembly Bias.

How will this effect constraints on Growth Rate inference?

Infer Growth Rate

- Use biasing models with and without assembly bias.
- How much information can be extracted from small-scales without having a correct model?

Simulate Observation (HW13)

Hearin+2013

Maximum realistic galaxy assembly bias

— Connects galaxy luminosity to halo **Vpeak** through abundance matching. (Vpeak is peak max. circular velocity reached by halo during assembly)

 Reproduces SDSS projected 2PCF in luminosity bins.

Investigation of Potential Systematic



Growth Rate Estimator

Combination of monopole and quadrupole 2PCF

$$\widehat{f\sigma_8}^2 = rac{7}{48} \left[5\left(7 ilde{\xi}_0 + ilde{\xi}_2
ight) - \sqrt{35}\left(35 ilde{\xi}_0^2 + 10 ilde{\xi}_0 ilde{\xi}_2 - 7 ilde{\xi}_2^2
ight)^{1/2}
ight]$$

Central-only growth curve insensitive to assembly bias down to s=9 h⁻¹Mpc.

Percival+2009

Investigation of Potential Systematic



Models

Halo Occupation Distribution (HOD) Depends only on present day host halo mass. Without Assembly Bias

Subhalo Clustering Abundance Matching (SCAM) Macc- Halo mass at time of accretion Vacc- Max circular velocity at time of accretion. Vpeak- Peak Max circular velocity reached during halo history. (Same as HW13) With Assembly Bias

Guo+2016

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Results



Conclusion

In a Universe with galaxy assembly bias, incorrect biasing models may be used to correctly infer cosmic growth rate at separation scales above s~8 h⁻¹Mpc if:

—Observe only the central galaxies. otherwise,

— Employ a flexible satellite prescription or predict galaxy-halo connection perfectly.



Current Project

How significant is galaxy assembly bias signal in 'real-world'?

Yes: Yang+2006; Wang+2013; Lacerna+2014

No: Lin+2016 (spatial 2PCF)

Discrepancy? Halo mass estimates.



0.6

0.5

Summary and Future Work

Summary

- Incorrect biasing models can be used down to s~8 h⁻¹Mpc to infer cosmic growth rate if observing only central galaxies.
- Otherwise, a flexible satellite prescription must be used or the exact assembly-sensitive halo property must be predicted below s~20 h⁻¹Mpc.
- True level of galaxy assembly bias signal is unknown.
- Current observations suffer from central/satellite discrimination and halo mass estimations. *HOD* + *Velocity bias may highlight signal.*

Future Work

- Characterize and quantify the scale dependent impact of galaxy assembly bias on growth rate constraints.
- Predict constraints of cosmic growth rate for upcoming Dark Energy surveys (DESI)

Thank You!