Analyzing Cluster Finders with Realistic Mock Catalogs

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1.Introduction

Clusters have been rising as one of the key ingredients to constrain cosmological models, along with other surveys such as supernova surveys and CMB surveys. Testing and calibrating analysis tools against realistic mock catalogs is essential in extracting useful information from cluster surveys. We present a novel way to create realistic mock catalogs for cluster surveys. One of the advantages of our strategy is that it is easy to modify galaxy properties since they are parametrized.

2-1. Creating Mock Catalogs

Galaxy Types: BCGs, Blue, Red by blue frac. $f_b=f(M_{200},r/r_{200})$

$f_b=A(M_{200})f_b(r/r_{200})f_b(M_k)$ with $f_b(z)=f_b(z=0)(1+z)^{\gamma blue}$

Galaxy Luminosity: Cluster (K*=-24.34) Field (K*=-24.16)

Field K*=-24.16 ± 0.05

HOD evolution: $N(M,z)=N(M,0)(1+z)^{\gamma HOD}$

Galaxy Colors: Red – modeled assuming passive evolution since formation with varied metallicities[1]

Blue – directly sampled from FLAMEX survey data

Intrinsic scatter in color-magnitude relation= 0.075 ± 0.05

Galaxy photo-z: directly sampled from FLAMEX dataset

N-body sim. Halo / Subhalo catalogs (provided by M. Warren in LANL)

$$S/N = \sqrt{\sigma_{src}^2/(\sigma_{src}^2 + \sigma_{bkg}^2 + \sigma_{sys}^2)}$$

2-2. Modifications

- Galaxy properties are parametrized so that it is easier to modify them.
- Good in estimating systematic errors in analysis due to the uncertainties in observation of those parameter values.
- Specified in green boxes in the above flow chart.

3. Application

- Mock catalog for SDSS-like survey applied to test a cluster finder (VTP cluster finder by W. Barkhouse).
  - VTP method = Voronoi Tessellation + red-sequence
  - VTP outputs = center, redshift, and Bgc values for identified clusters
- Tests against realistic mock catalogs : completeness and contamination, redshift estimates calibration (Figure 1).
- Bgc is measured and compared with halo mass, M_{200}.
- Scatter is consistent with Gaussian σ=0.25 and does not seem to depend on halo mass.
- Scatter does not seem to depend on redshift (Figure 2).

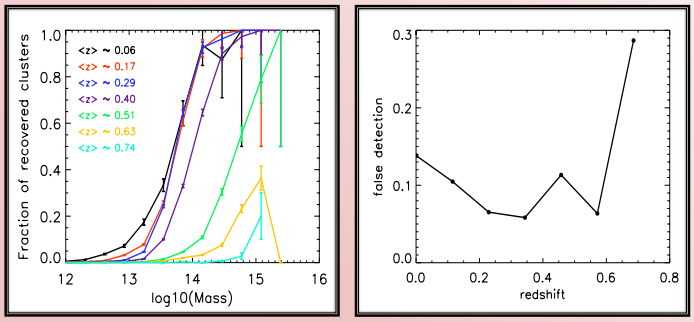

Figure 1. Completeness as a function of redshift and cluster virial mass and contamination as a function of redshift.

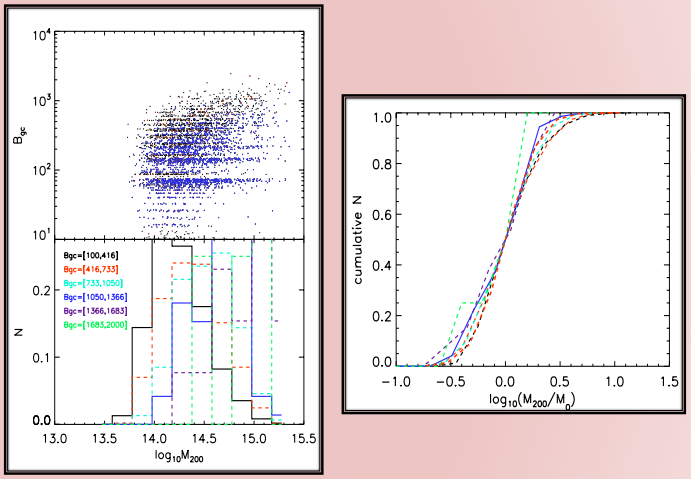

Figure 2. Bgc scattter as a function of cluster virial mass.

4. Conclusion

- Realistic mock catalogs are crucial in understanding cluster samples from large sky surveys.
- Parametrizing galaxy properties gives an easy leverage in assigning and modifying their observational values.
  - Observational uncertainties of those galaxy properties yield systematic uncertainties in completeness at the level of approximately 0.03.
- Implementing HOD as an input parameter allows us to create mock catalogs at different survey depth.
  - Probing 1 magnitude deeper than SDSS improves the cluster finding by 5%.

References

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