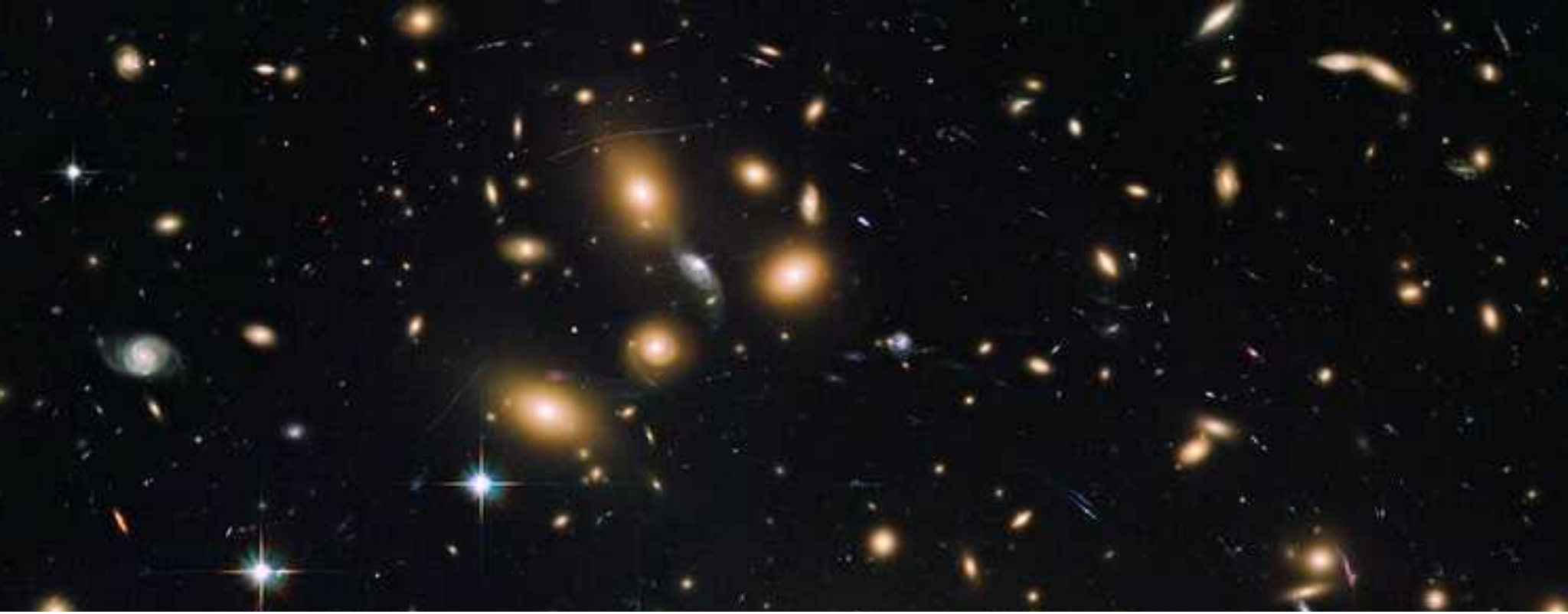


USING A MOCK CATALOGUE TO IMPROVE GROUP FINDERS ALGORITHMS

MOCK CÓRDOBA- APRIL 10

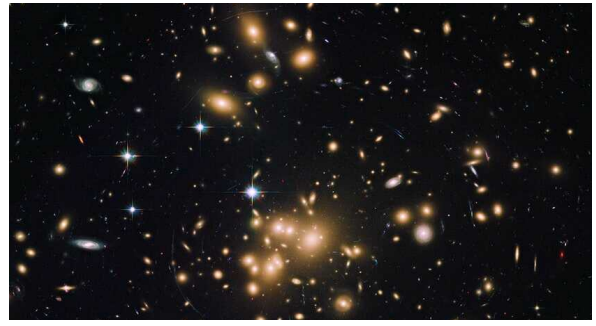
FACUNDO RODRIGUEZ - MANUEL MERCHÁN

IATE CONICET UNC

UNC Universidad Nacional de Córdoba

OAC Observatorio Astronómico de Córdoba

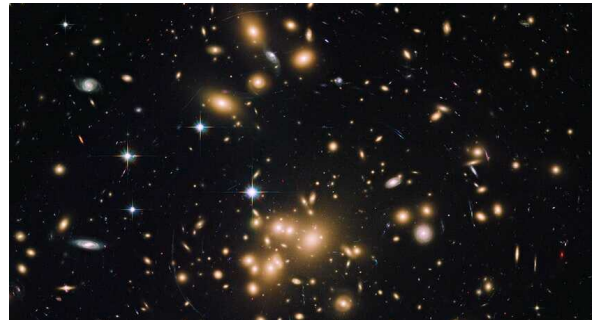




Introduction

- A common way to link observation with simulations is using galaxy groups as halos tracers.
- There are different group finders that recover different groups.
- The two most employed group finders are:
  - **Friends-Of-Friends.**
  - **Halo-based group finder.**





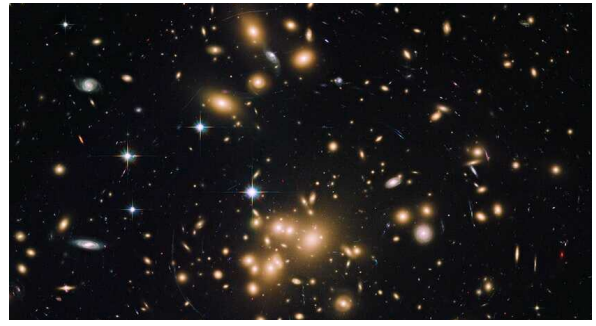
Friends-Of-Friends

Outline

- It is applied to select groups in a redshift survey, using only galaxy angular positions and observed redshifts.
- A pair of galaxies is linked if both their transverse and line-of sight separations are smaller than a specified pair of projected and line-of-sight linking lengths, respectively.
- It is an algorithm that links all galaxies that obey the linking condition to each other, thus yielding a unique catalogue galaxy groups.
- **It is only based on an imposed overdensity and a correction factor for the distortion of the redshift space.**

- E.g: Merchán, M. E., & Zandivarez, A. (2005). *Galaxy groups in the third data release of the sloan digital sky survey*. The Astrophysical Journal, 630(2), 759.



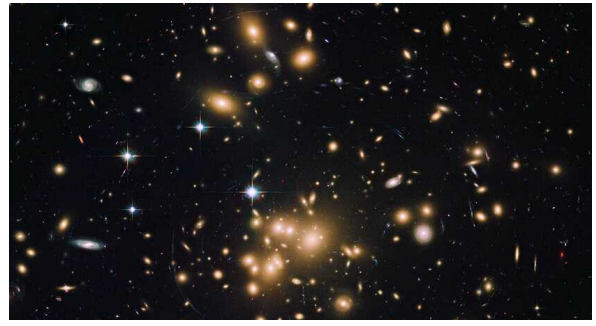


Friends-Of-Friends

Disadvantages

- It is not reliable for groups with few members ($N \geq 4$).
- It has a lot of interlopers.
- It does not take into account galaxies luminosity to determine their membership to the groups.
- It tends to artificially merge the structures.
- It has a lot of completeness but many fake groups.
- It is not suitable for some studies (E.g Halo Occupation Distribution).





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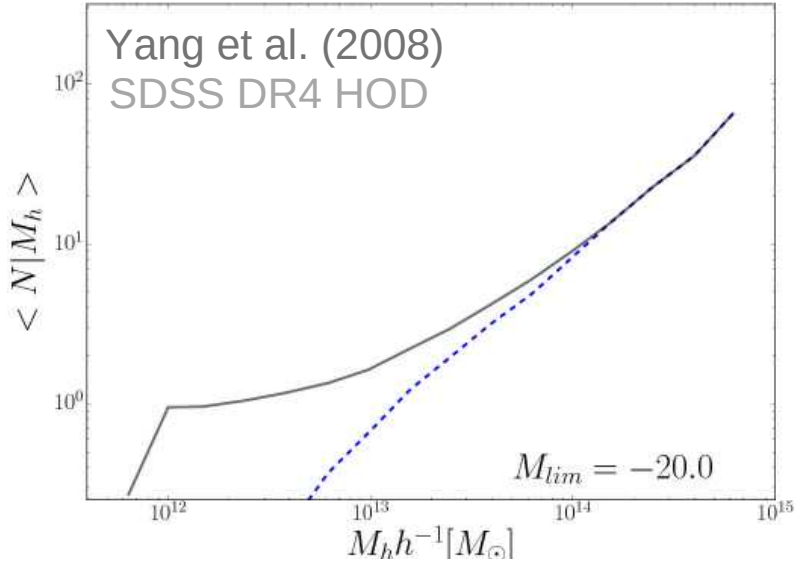

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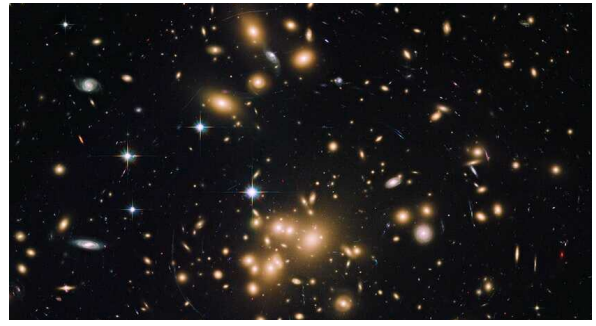


Halo-based group finder

Outline

- It is iterative algorithms based on phase-space properties of dark matter haloes.
- **It assumes that galaxies follow a spherical NFW profile as dark matter.**
- **Membership of galaxies is conditioned to their luminosities .**
- All galaxy groups have at least one bright galaxy.
- Halo Mass estimation is part of the method and it is assigned using abundance matching on luminosity.
- E.g: Yang, X., Mo, H. J., Van Den Bosch, F. C., & Jing, Y. P. (2005). *A halo-based galaxy group finder: calibration and application to the 2dFGRS*. Monthly Notices of the Royal Astronomical Society, 356(4), 1293-1307.

Goal of this work

To improve the FOF algorithm incorporating the halo definition of Halo - Based finders

Steps:

1. To perform a FOF by applying luminosity constraints.

2. To improve it by applying the halo-based finders technique

Performing group finders

Friends-Of-Friends

- We select groups following Huchra & Geller (1982) linking pairs of galaxies when the transverse (D_{12}) and line-of sight (V_{12}) separations are smaller than a specified projected and line-of-sight linking lengths.
- Linking lengths take into account the number density variation due to the apparent magnitude limit of the survey (R).

$$D_{12} = 2\sin\left(\frac{\theta_{12}}{2}\right) D \leq D_L = D_0 R \qquad V_{12} = |V_1 - V_2| \leq V_L = V_0 R$$

$$R = \left[\frac{\int_{-\infty}^{M_{12}} \phi(M) dM)}{\int_{-\infty}^{M_{lim}} \phi(M) dM)}\right]^{\frac{1}{3}}$$

Performing group finders

Friends-Of-Friends
Luminosity constraints

- We apply restrictions to the absolute magnitude of the galaxy members:

  - We consider only groups that have at least one bright galaxy.
  - We do not apply any restrictions on the number of members.
  - Add as potential groups bright not linked galaxies.

Performing group finders

Halo-based group finder

1. Find potential group centers
    - It starts with tentative groups identified using the FOF method.
    - The centers of identified groups with two members or more are considered as potential centers.
    - All galaxies not yet linked to these groups, are also treated as tentative centers of potential groups.

2. Determine the characteristic luminosity of each tentative group.
    - The group's characteristic luminosity ($L_{19.5}$) is defined combining luminosity of all group members with $M_r \leq -19.5$.

Performing group finders

Halo-based group finder

3. Estimate the mass, size, and velocity dispersion of the dark matter halo associated with each tentative group.

- Using the value of $L_{19.5}$ determined above and an assumption for the group mass-to-light ratio ($M_h/L_{19.5}$) a mass is assigned to each group.

  (**Abbundance matching**)

- Using the halo mass, the halo radius (r) and the line-of-sight velocity dispersion (σ) are calculated.

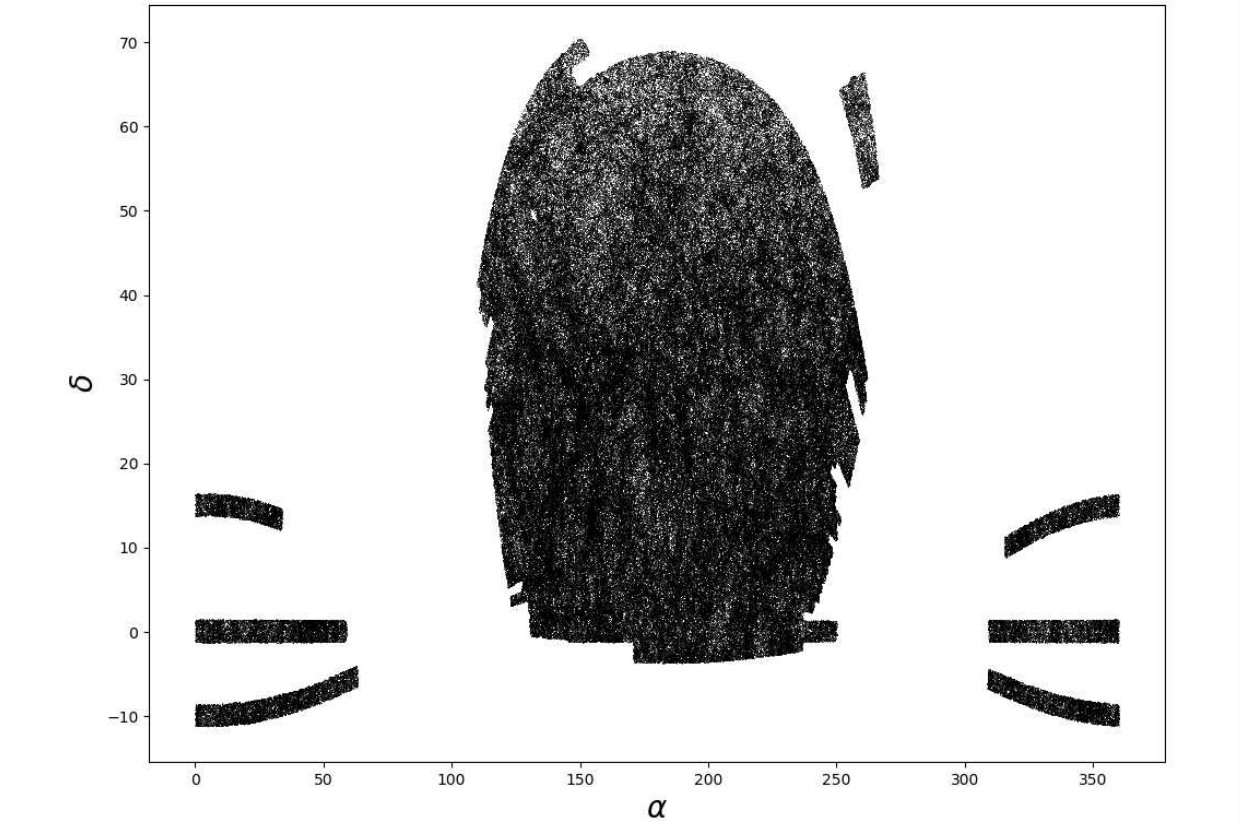
Performing group finders

Halo-based group finder

4. Update group memberships using halo information.
    - It is assumed that the number density contrast of galaxies in the redshift space around the group center at redshift follows that of the dark matter.
    - It is defined $P_M(R, \Delta z)$ as the three-dimensional density contrast in redshift space and decide whether a galaxy should be assigned to a particular group if: $P_M(R, \Delta z) \geq B$

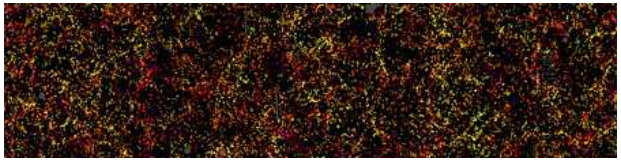
5. Iterate.
    - This iteration process goes on until there is no further change in the group memberships.

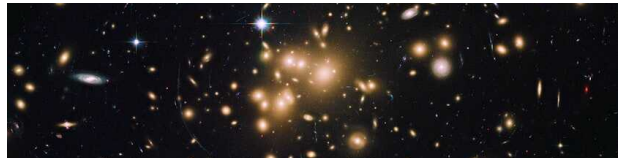
Galaxy mock catalogue



SDSS mask to reproduce the geometry.

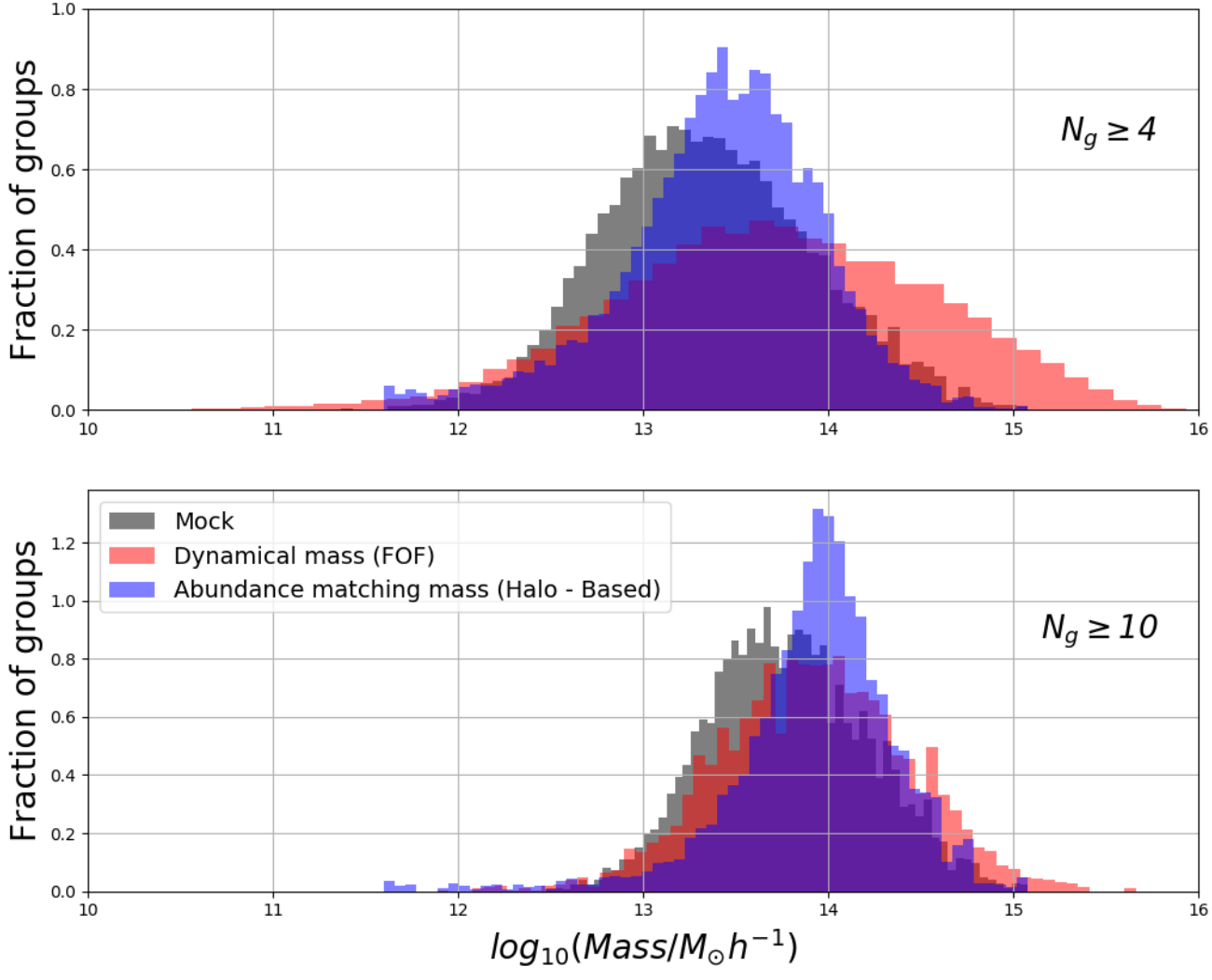
Semi-analytical model of galaxy formation (Guo et al. (2010)) applied on the Millennium I simulation (Springel et al., 2005).

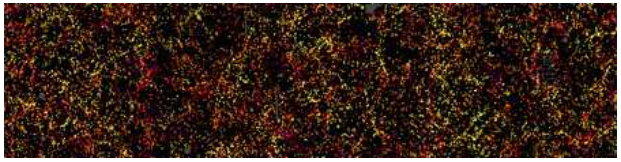




Results

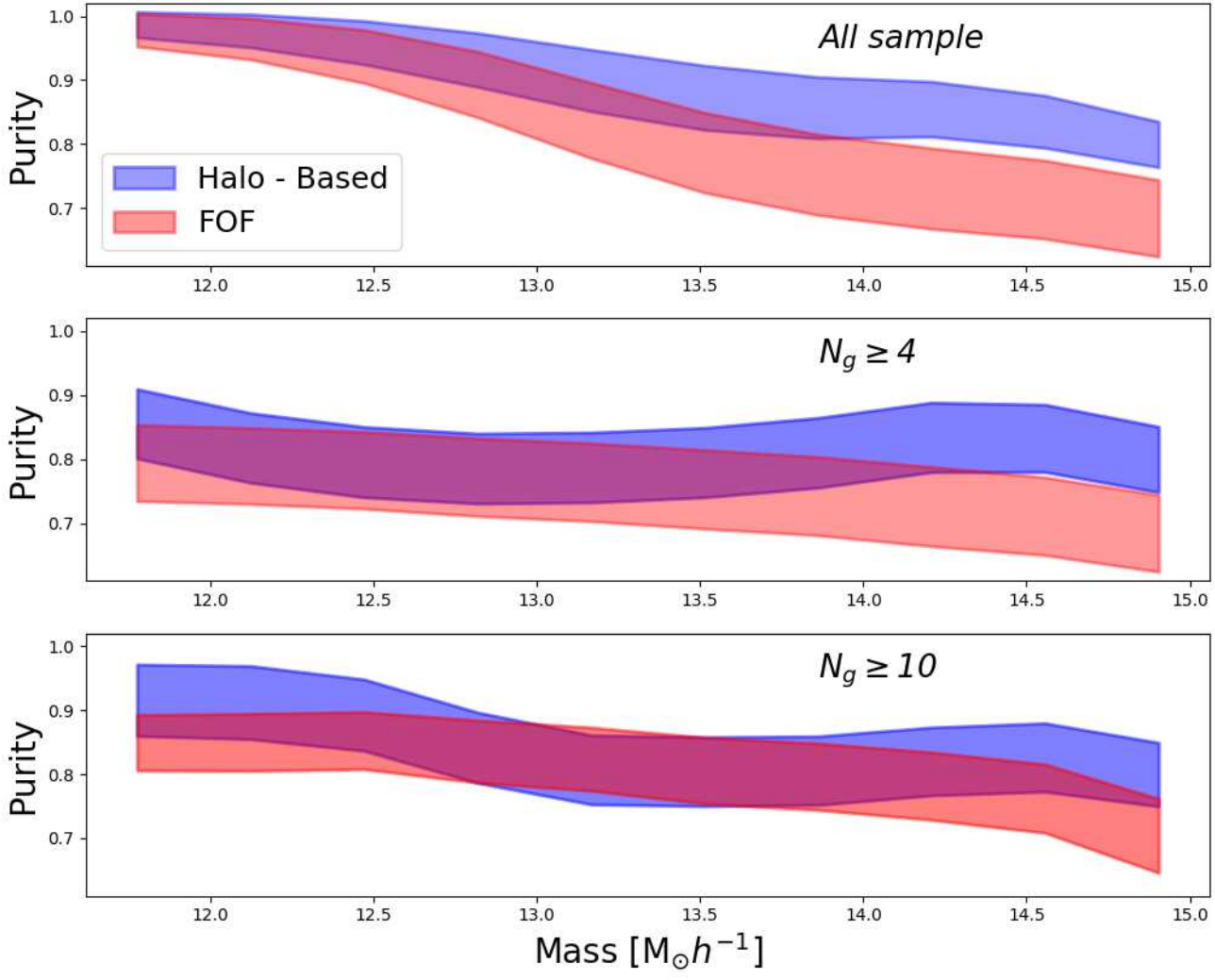
Mass comparison

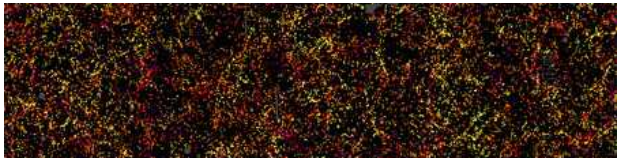




Results

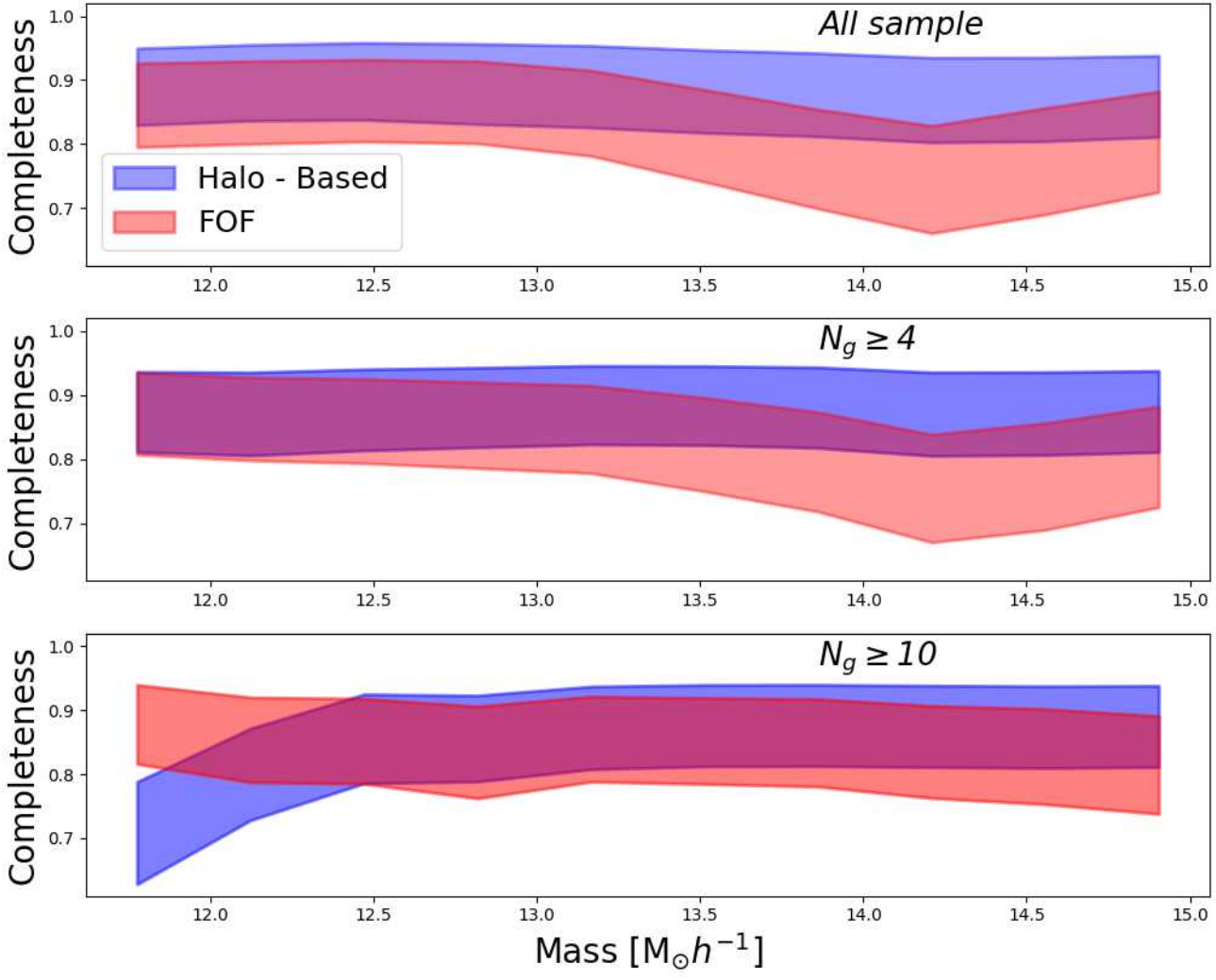
Purity

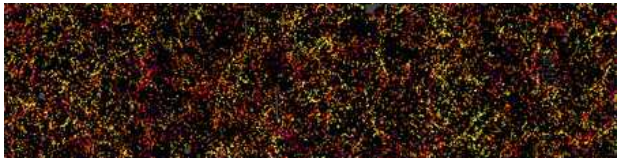


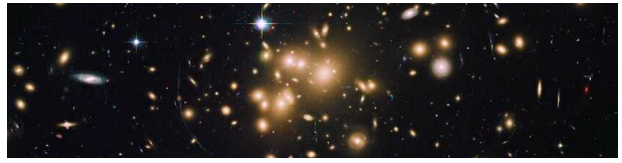


Results

Completeness

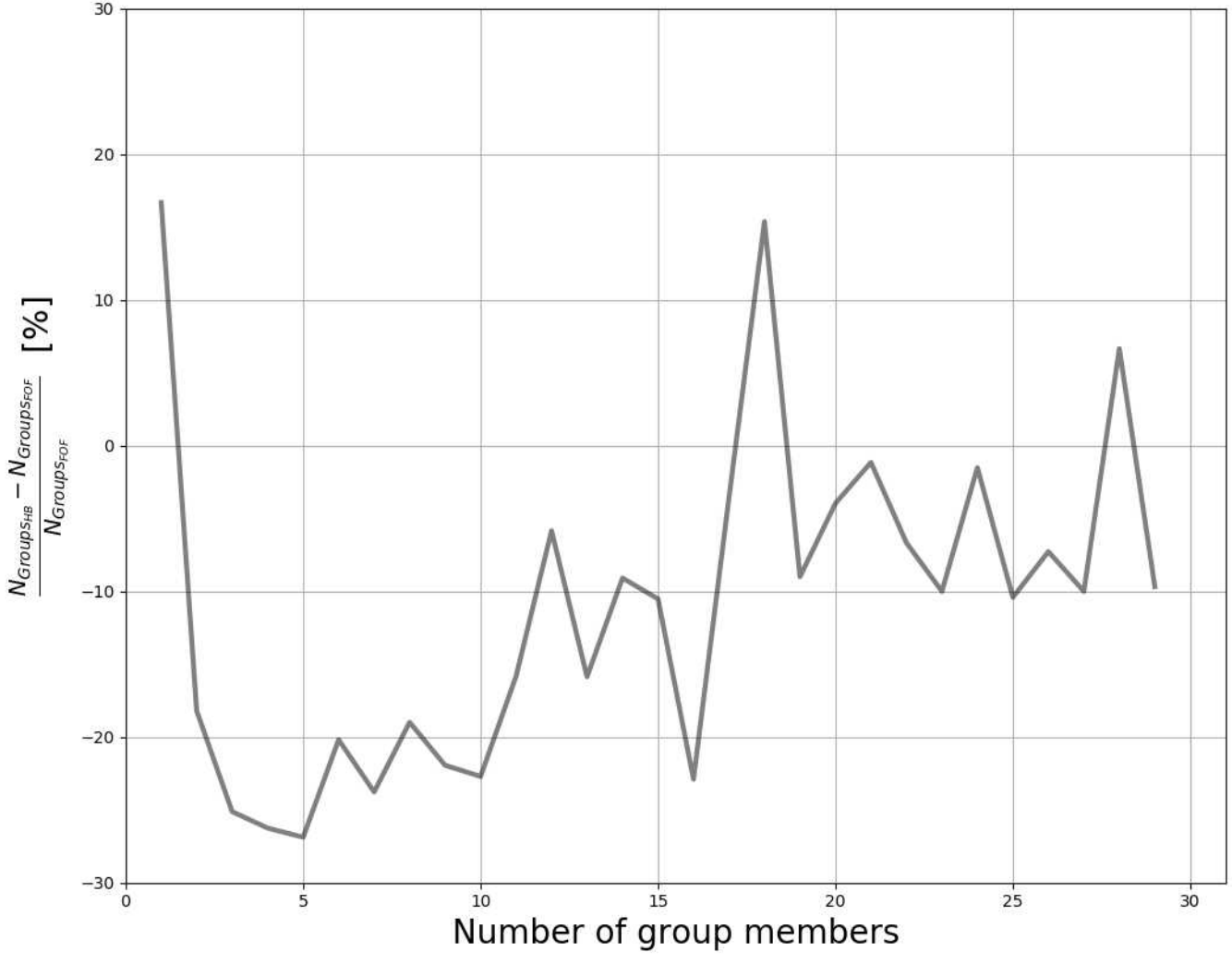


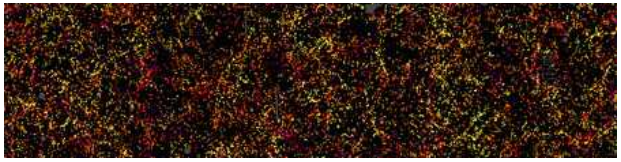




Results

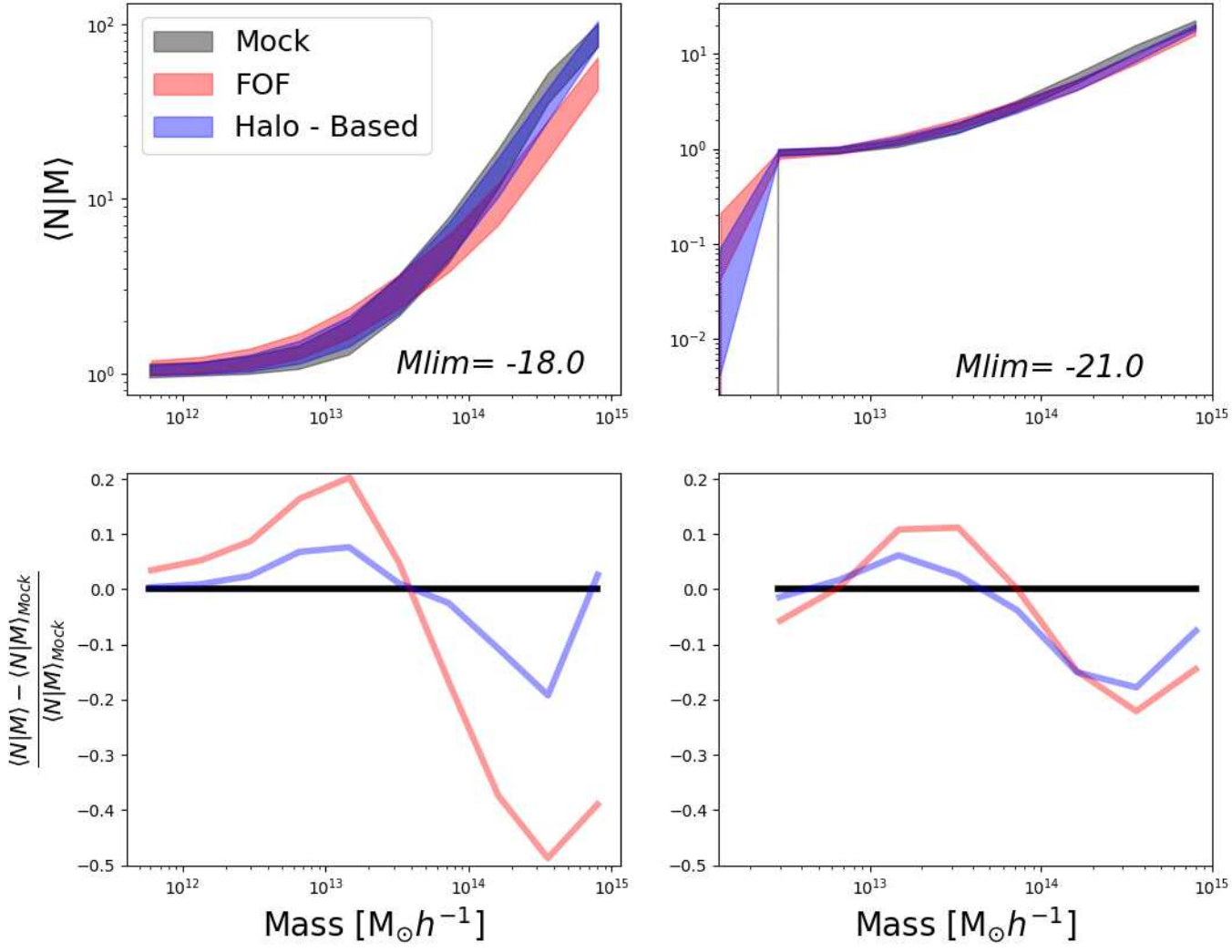
Ratio of the groups with the same number of members

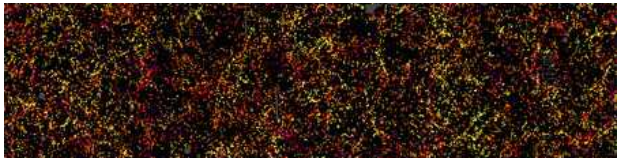


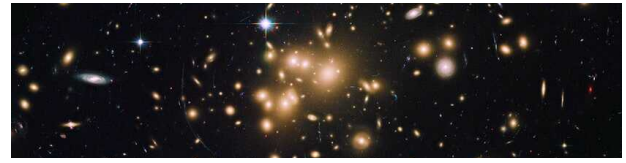


Results

Halo Occupation







Conclusions and future work

- We combined a full FOF algorithms with and Halo - Based method to improve the group identification.
- Using a mock catalog to test our algorithms, we demonstrate the reliability of our groups.
- The next step is to implement this same procedure to obtain reliable groups in the SDSS.

Thanks for your attention!