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MASS RATIO EVOLUTION IN CLUSTERS BETWEEN HALOS AND SUB-HALOS

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Abstract. Structure in our universe grow hierarchically, where small structures (stars and galaxies) assemble first and later on galaxies group and proto-clusters together in large potential wells to form clusters. Clusters of galaxies are the largest structure observable in our Universe and can contain more than hundreds of galaxies. We believe that every galaxy carries its own small halo of dark matter, and when they fall in a cluster part of that halo is stripped and diffused in the larger halo of the cluster. I will present here, how I am using the strong gravitational lensing effect in combination with IFU of cluster fields to answer questions on the evolution of the halos and sub-halos dark matter components. Indeed galaxies and their dark matter falling in the cluster and losing their dark matter to the profit of the cluster also called the sub-halos mass loss. In the future, I will use a large number of models spanning a wide range of redshifts (0.3 < z < 1.0) to show how cluster transfer their mass from their cluster members to their host halos.

Keywords: gravitational lensing, strong gravitational lensing, galaxy cluster, galaxy mass

1 Introduction

Clusters of galaxies are located at the nodes of the cosmic filaments and represent the densest structures of dark matter; their merging history and evolution shape the properties of their mass distribution. The density profiles of massive galaxy clusters show strong self-similarity up to z∼2 outside of cluster cores (McDonald et al. 2017), but depart from this self-similarity within cluster cores. While X-ray, SZ, and/ or weak lensing studies have been able to accurately probe the outer region of clusters, the inner core profile is much better probe with different methods such as strong lensing (e.g. Newman et al. 2009)

2 Methods

Simulations have shown that a large fraction of the mass from subhalos merge with the host and only up to about 20% of it remain within cluster member galaxies (Wu et al. 2013). This scenario implies that through their life the cluster sub-halos fraction mass can change. Building on such realization I gathered clusters from the South Pole Telescope catalog, see left panels Fig. 1. Adding mass evolution relation from simulation and modeling of a few clusters showing very peculiar subhalos mass fraction we are tempted to draw a relation between subhalos mass fraction and redshift evolution. To remove some biases and degeneracies among parameters during the strong lensing modeling, we can use dynamical information when available. Based on galaxy-galaxy strong lensing relation from Bolton et al. (2007). We can use the relation between velocity dispersion, with effective radius and mass Using this relation we are able to test this on cluster member galaxies under the assumption that the inner core of field elliptical is similar to the one of cluster member galaxies. To do so I used one of the most constrained cluster, Abell 370 (Lagattuta et al. 2019) due to its large spectroscopic coverage and well constrained strong lensing model.

3 Results and Conclusions

Fitting all of the cluster members spectra using PPFX (Cappellari 2017) fitting software. We were able to fit 119 different cluster member galaxies The depth of the data allowed to reach a faint cluster member galaxies 0.05 $L^\star$ Before investigating the spread in mass for cluster members we compared the dynamical mass to the

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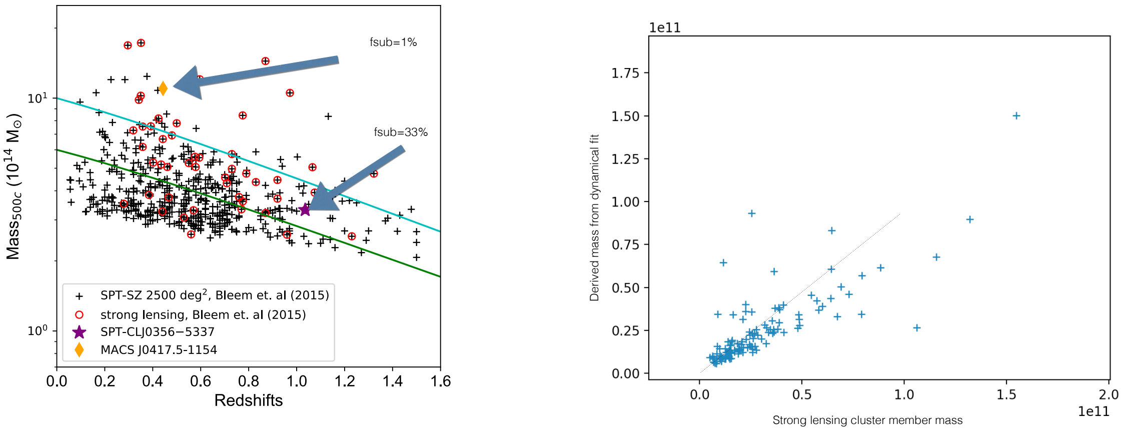

Fig. 1. Left: Mass redshift diagram of South Pole Telescope cluster sample from Bleem et al. (2015). Green and cyan line represents the mass evolution for clusters to guide the eye. The two arrow points toward cluster with very peculiar sub-halos mass fraction from Mahler et al. (2019, 2020) **Right:** Mass comparison between the mass derived from the strong lensing models optimized only using strong lensing constraints and the masses derived from the dynamical formula in Bolton et al. (2007)

mass directly directed from the strong lensing fit (See right panel Fig. 1) This figure show a nice correlation, however slightly biases in the 1:1 relation. Indeed it seems that the most massive galaxies fitted in the strong lensing minimization tends to be more massive that what predicted from their velocity dispersion. This could be due to the interplay between the cluster scale halo and the biggest cluster member galaxies. This might also be a hint for a non-constant mass-to-light ratio in our cluster. In the future, I will extend the sample of cluster used and try to directly inject the dynamical mass estimate in the cluster to model it.

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