

Title: Multiwavelength views on the mass distribution of galaxy clusters: The case of Abell S1063

Abstract: Galaxy clusters are the greatest structures bound by gravity in the cosmos. Such massive objects bend the light from background objects, allowing us to study their mass contents with the gravitational lensing effect. In the context of the standard cosmological model, their contents are largely dominated by dark matter (DM) and are thus a unique laboratory for studying its properties.

As the gravitational lensing is probing the total mass, the complete disentanglement of the DM from the rest of the baryonic matter (i.e. ordinary matter) can only be obtained from a multiwavelength analysis. In such a study, the electromagnetic emission from the baryons is used to recover their intrinsic mass distributions to extract the DM from the total one in a cluster. The baryons are distributed among the intra-cluster gas, the galaxy's baryons and the intra-cluster stars. The gas is gravitationally heated to a state of hot plasma and emits in X-ray; thus, it can be mapped by X-ray spatial observatory imaging. The baryons in stars are constrainable by their optical emission through photometry and spectroscopy. They require a different treatment consistent with their nature. Indeed, the intra-cluster stars appear as a faint diffuse cluster-scale light emission (i.e. Intra-Cluster light denoted ICL) when the galaxies are bright and compact.

Recent studies have shown that it was possible to make a self-consistent mass distribution model separating the intra-cluster gas from the rest of the mass to benefit from X-ray constraints (Beauchesne et al., 2024). The first JWST observations demonstrated its ability to map the ICL in a fraction of the observing time previously required and allowed its inclusion into galaxy cluster mass models. Hence, it now seems technically possible to fully disentangle the DM mass distribution from its baryonic counterpart at the cluster-scale.

We will present a modified version of the method presented in Beauchesne et al. (2024), where we include a new mass component to reproduce the ICL. We extend the set of observables by adding direct constraints on the velocity dispersions for the cluster member and the ICL. The produced models can be split into each main cluster component, and each baryon component is fitted on specific observables jointly with the lensing. We will show the difference between the DM-only and the total mass slopes on our cluster test case, Abell S1063. From these differences, we will assess where the interplay between DM and baryons could have biased previous DM measurements based on the total mass profile. We will present how well the ICL is tracing the DM and total mass in our case and how it performs compared to other probes, such as the X-ray emitting gas.