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Probing the luminous and dark matter profiles in the inner regions of a group-scale lens at z = 0.6

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Abstract. Studying the density profiles of galaxy groups offers an important insight on how large-scale structure in the Universe formed and evolved, since galaxy groups bridge the gap between individual galaxies and galaxy clusters. We aim to probe the total density profile of the galaxy group that is gravitational lensing HELMS18, a submillimeter galaxy at $z = 2.39$ from the Herschel's HerMES Large Mode Survey (HELMS), by combining strong gravitational lensing with kinematics of the centrally-located galaxies and kinematics of the group members. We will use high-resolution data of HELMS18 obtained with the Atacama Large Millimeter/submillimeter Array (ALMA) and multi-object spectroscopic data of the group members from Gemini-GMOS. Our final goal is to combine these observations to probe the stellar and dark matter density profiles and to build a complete description of this galaxy group.

Keywords. gravitational lensing: strong, galaxies: groups, galaxies: general, galaxies: high-redshift

1. Introduction

Characterizing the mass distribution of galaxy groups and clusters is one of the challenges of modern Cosmology. Detailed studies of their internal mass distributions can be used to test and constrain the model of structure formation and evolution (Bartelmann *et al.* 2013). Of particular interest is the radial density profile of dark matter, which is sensitive to baryonic processes, such as AGN and stellar feedback. As these processes vary with mass and formation history, it is important to examine the baryonic and dark matter distributions across the full mass range, from individual galaxies to galaxy clusters. It is now widely recognised that gravitational lensing is the most suitable tool for measuring the distribution of mass (dark+baryonic) for this wide range of systems. Modelling the strong lensing effect allow us to measure the total mass within the system of multiple images, defined by the Einstein radius. Combining strong lensing technique with other observations, such as weak lensing and stellar kinematics of the centrally-located galaxies, allow us to measure the density profile at different radii. While some studies suggest that baryons and dark matter follow a nearly isothermal density profile in early-type galaxies (ETGs), other studies found that the inner dark matter density profile in galaxy clusters is shallower than the Navarro-Frank-White slope, suggesting a connection between the inner halo and the baryons in the central galaxies (Sand *et al.* 2008; Newman *et al.* 2013). Such techniques have been mainly applied to galaxy-scale and cluster-scale lenses, so the main goal of this project is to bridge the gaps in the measurements of the density profiles of small and large scale structures.

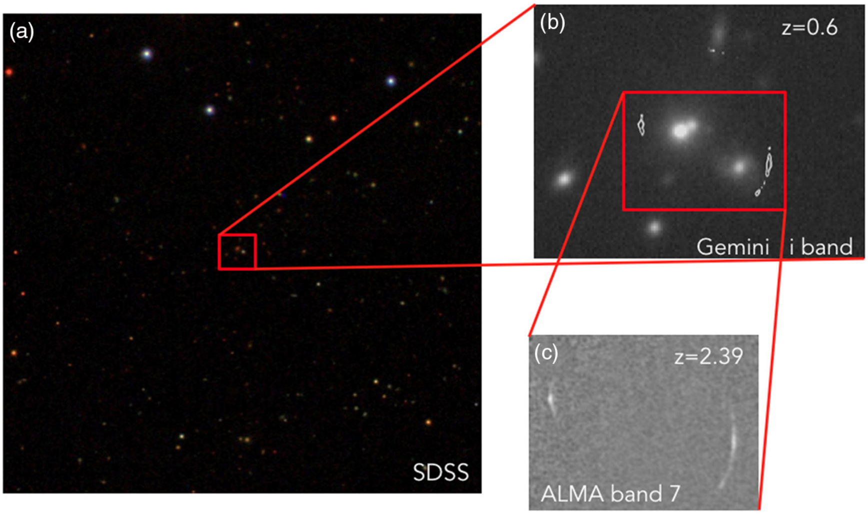

Figure 1. SDSS colour-composite image of the galaxy group (*a*). Superposition of Gemini and ALMA data (white contours) of the inner region of the group (*b*). ALMA band 7 data of HELMS18 (*c*).

2. Data and Methods

In this work we use ALMA band 7 data, which show two gravitational arcs (Figure 1c). According to Amvrosiadis *et al.* (2018), HELMS18 system has an Einstein radius of $\sim$6.5″. Optical images from Sloan Digital Sky Survey (SDSS) show that the lensing group has two central galaxies, an ETG and a quasar candidate (Figure 1a). Spectroscopic data from SDSS (for the ETG) indicate that the group is at $z \sim 0.6$.

Currently we are modelling the ALMA data using the semi-linear inversion method outlined in Dye *et al.* (2018), which works directly in the interferometric uv-plane on the visibility data. With the modelling we aim to: *i*) measure properties of the lens; *ii*) measure the slope of the density profile; *iii*) reconstruct the image of the lensed galaxy; and *iv*) investigate properties of the lensed galaxy.

As part of this project we proposed to conduct Gemini Multi-Object Spectroscopy observations to target both the candidate group members and the two brightest central galaxies. Our proposal was accepted and observations are ongoing.

Gemini data will allow us to investigate stellar kinematics of the central galaxies, determine the group members and estimate the luminous density profile and total stellar mass. Combining strong lensing with stellar kinematics of the centrally-located galaxies and kinematics of the group members, we will measure the mass distribution at different radii.

References

Bartelmann, M., Limousin, M., Meneghetti, M., Schmidt, R., *et al.* 2013, *Space Science Reviews*, 177, 3

Sand, D. J., Treu, T., Ellis, R. S., Smith, G. P., Kneib, J.-P., *et al.* 2008, *ApJ*, 674, 711

Newman, J. A., Cooper, M. C., Davis, M., Faber, S. M., Coil, A. L., Guhathakurta, P., Koo, D. C., Phillips, A. C., *et al.* 2013, *ApJS*, 208, 5

Amvrosiadis, A., Eales, S. A., Negrello, M., Marchetti, L., Smith, M. W. L., Bourne, N., Clements, D. L., De Zotti, G., *et al.* 2018, *MNRAS*, 475, 4939

Dye, S., Furlanetto, C., Dunne, L., Eales, S. A., Negrello, M., Nayyeri, H., van der Werf, P. P., Serjeant, S., *et al.* 2018, *MNRAS*, 476, 4383