CHARACTERISING THE OPTICAL PROPERTIES OF A2626 GALAXIES

Level of project: Masters
Supervisors: Dr Julia Healy (University of Manchester) – julia.healy@manchester.ac.uk and A/Prof. Sarah Blyth (University of Cape Town) – sarah.blyth@uct.ac.za
(Student would be registered at UCT)

PROJECT SUMMARY

Galaxies in clusters provide a unique laboratory for studying galaxy evolution due to their dense environments and the strong external forces at play. One key observational feature that can shed light on a galaxy's history is its colour gradient, i.e. the variation in colour from the galaxy's core to its outskirts. This project aims to analyse the colour gradients of galaxies in the Abell 2626 galaxy cluster to better understand how environmental factors influence galaxy evolution.

We have data for the Abell 2626 (A2626) galaxy cluster already at a range of wavelengths including publicly available optical imaging, proprietary optical spectroscopy and interferometric radio data (see Healy, Willner+ 2021, Healy, Deb+ 2021). In 2019, we started with a 15 hour pointing with MeerKAT to observe the neutral atomic hydrogen (HI) in the cluster, this was extended in 2021 and 2023 to observe a total of 9 pointings with MeerKAT at higher spectral resolution – this has become the PRABHA survey. All these observations have enabled us to identify substructure within the cluster and explore how the HI content of the cluster galaxies is being affected by the local (substructure) and global (cluster) environments. However, what has yet to be explored, is how the optical properties of the galaxies are affected in these different environments.

In this project, we will be exploring the optical properties of the galaxies, through analysis of colour gradients within the galaxies in the different environments. The colour gradient in a galaxy reflects variations in its stellar populations, star formation history, and metallicity. The colour gradient can serve as a valuable diagnostic tool to trace how galaxies evolve over time.

In galaxy clusters, several mechanisms impact colour gradients:

- **Ram Pressure Stripping:** Removes gas from the outer regions, suppressing star formation and steepening the colour gradient (Boselli & Gavazzi, 2006).
- **Galaxy Harassment:** Frequent high-speed interactions disturb stellar populations, potentially altering gradients (Moore et al., 1999).
- **Mergers and Quenching:** Mergers flatten or reverse gradients, while quenching processes cause gradual reddening as star formation ceases (Schawinski et al., 2014).

GOALS OF THE PROJECT

Derive an optical catalogue for the cluster: The first goal of the project will be to create a photometric catalogue of galaxies in the PRABHA survey starting with the central part of the cluster and moving out with radius. Measurements in this catalogue should include

(but not be limited to), total magnitudes, surface brightness profiles, R_{25}, and other relevant morphological parameters.

Explore how the optical properties are impacted by the different environments around A2626: The newly created photometric catalogue will enable us to explore how the colour gradients, and other morphological parameters vary across different locations within the cluster. This will provide insight into what processes are driving the evolution of the galaxy. These insights can then also be compared to what is seen in the HI from the PRABHA field to provide a holistic view of the ongoing evolution in the A2626 cluster.

Feasibility

The optical data to be used by this project are from the publicly available DECAM Legacy Surveys DR9 and DR10 which is of sufficient quality for this project. The candidate will be required to develop a pipeline using existing Python-based tools such as Photutils within the AstroPy framework to identify the cluster galaxies, and extract several photometric parameters from the galaxies across the PRABHA survey's field of view. These data will then be analysed as part of the research project.

Requirements of candidates

This project will make use of reduced optical data to measure the optical properties of galaxies, and Python skills will be required. Exposure to visualisation tools such as CARTA, and catalogue management tools such as TopCat would be helpful but can also be learnt during the project.