Title: Galaxy Cluster Environments Traced by HI

1. Level of the project

- Honours

2. Primary supervisor's details

- Full name of the primary supervisor
  Dr Mpati Ramatsoku
- Primary supervisor's email address
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- University where the primary supervisor is employed
  Rhodes University

3. Research project summary:

Galaxies are largely composed of gas and stars, and their interactions cause them to evolve over time. During this process, galaxies eventually exhaust their cold and dense gas reserves necessary for star formation. However, determining the exact point at which this occurs is not as simple as calculating the amount of gas in a galaxy divided by its star-forming rate. There are several processes that can deplete gas or prevent it from cooling and condensing to form stars. While we understand these processes well, there are still unanswered questions, such as where they occur and which process has the most significant impact. Observations have shown that the environment of galaxy clusters, with their high density of galaxies, has a profound effect on galaxy evolution. Studies of cold neutral atomic gas (HI) have also highlighted the importance of examining the cluster environment's effects on galaxy evolution due to the sensitivity of this gas phase to harsh cluster conditions. However, some aspects of the puzzle remain missing due to limitations imposed by previous radio instruments.

This project aims to utilise the higher sensitivity of the MeerKAT telescope to study the HI properties of galaxies within the A85 galaxy cluster with a total mass of M_{200} ~ 1.6×10^{15} $M\odot$ and a velocity dispersion of σ_{cl} ~ 982 ± 55 km/s. This cluster is nearby at a redshift of z~ 0.05. It comprises a sufficient number of resolved HI discs necessary for this study. It also hosts several galaxies with optical tails, indicating environmental processing in the cluster.

The goals of this project are as follows:

Characterise cluster environments: The cluster is expected to host several substructures which form its overall morphology. Characterising these substructures will provide a means to assess the various environments in which galaxies lie.

Search for HI tails: The spatially resolved HI detections will provide means to quantitatively characterise and study the detailed morphologies of HI in galaxies as a function of their distance from the cluster centre. This will effectively explain the various environment-specific mechanisms acting upon the galaxies.

Feasibility
The required HI data for this project have already been gathered and are currently accessible. They are of sufficient quality for this study. A significant portion of the analysis for this project relies on ancillary data. The complementary optical redshifts for galaxy cluster members will be readily available from the Omega/WINGS catalogue.

To address the questions outlined in the project description, the student will be expected to conduct several key discussions and make several main plots, including but not limited to;

- Discussing the method used to characterise the various environments within the A85 cluster and a plot showing these environments.
- Discussing the HI morphology classification and making plots illustrating these morphologies as a function of distance from the cluster centre and the characterised environments.
- Concluding on the possible mechanisms at play in the environments and their impact on the global HI properties of the galaxies.

Requirements of candidates
A candidate requires a basic understanding of Linux operating systems and proficiency in either Python/Matlab or any other programming language.