**Project Title:** Galaxy Cluster Mergers in X-ray and Radio: A Comparative Analysis
**Research Area:** Astronomy
**Academic Level:** Honours
**Primary Supervisor:** Dr Swarna Chatterjee
**Co-supervisor:** Dr Kenda Knowles
**Institution:** Rhodes University

## Project Description:

Galaxy clusters comprise hundreds to thousands of galaxies embedded in a hot, X-ray-emitting intracluster medium (ICM) and permeated by magnetic fields. These environments often host diffuse, non-thermal radio emissions in the form of radio halos and radio relics, which are believed to trace turbulent re-acceleration and shock-driven particle acceleration, respectively. The presence and properties of this diffuse emission are closely linked to the dynamical state of the cluster. The dynamical state of a galaxy cluster, which describes whether it is relaxed or undergoing a merger, can be inferred from X-ray morphology using indicators such as surface brightness asymmetry, centroid shifts, and concentration parameters. Merging clusters, characterized by disturbed X-ray morphologies, often show enhanced turbulence and shock structures, which can contribute to the formation and evolution of radio halos and relics. However, not all the merging clusters host halos or relics.

This project aims to compile a catalogue of dynamically disturbed galaxy clusters that host diffuse radio emission by combining available X-ray morphology information with radio surveys such as MeerKAT Galaxy Cluster Legacy Survey (MGCLS), LOFAR Two-meter Sky Survey (LoTSS). The student will compare the X-ray-based classifications with radio properties to identify trends in the connection between cluster mergers and radio emissions.

## Methodology:

- Extract a list of dynamically disturbed clusters from X-ray observations.
- Cross-match these clusters with radio surveys (MGCLS, LoTSS) to check for associated radio emissions.
- Create a catalogue of disturbed clusters hosting diffuse radio emission.
- Compare the distribution of radio properties (such as flux density, and morphology) with the dynamical classification.

## Skills Required

- Experience with Linux environment and Python programming (helpful)

## Skill Development

- Basics of galaxy cluster physics (mergers, ICM properties, X-ray and radio observations).
- Understanding and handling astronomical catalogues.
- Scientific interpretation of observational trends.