1. Project level: Masters
2. Primary supervisor: Dr Kenda Knowles
3. Institution: Rhodes University
4. Co-supervisor: N/A
5. Institution: N/A
6. Contact details: kendaknowles.astro@gmail.com / k.knowles@ru.ac.za
7. Project title: Determining radio halo/mini-halo upper limits for MGCLS
8. Project description:

Sensitive radio observations of galaxy clusters across a wide range of cluster mass and redshift will advance our understanding of the effect of different physical environments on the evolution of diffuse cluster sources and the cosmic ray processes and magnetic fields that drive them. Clusters that do not host detectable diffuse emission still carry a wealth of information on the latter's formation mechanism, particularly where the clusters exhibit dynamical signatures. One prediction of the radio halo turbulent reacceleration model is a bimodal population in the radio power/X-ray plane, where non-detections are separate from halo-hosting clusters. To place these clusters in the context of the scaling relations, one needs to determine upper limits based on the cluster properties.

The first data release (DR1) of the MeerKAT Galaxy Cluster Legacy Survey (MGCLS) provides L-band data for 115 galaxy clusters, 63 of which have no visible centralised diffuse emission. In order to perform statistical analyses of the radio halos and mini-halos in MGCLS, radio upper limits need to be determined for these systems. The student will work with the supervisor and other members of the MGCLS consortium to create a (semi-)automated pipeline for upper limit determination, following the standard process which uses simulated halo injections, and test viability of image-injection techniques for when visibilities are not available (as expected in the SKAO era).

An estimated timeline (for an 18 month NASSP dissertation) includes:

- Literature review, including familiarising oneself with current upper limit techniques, and identification of a subset of MGCLS clusters for the project (~4 months)
- Development and testing of an upper limit generation pipeline using the visibility plane technique (~6 months)
- Investigation of image-based methods and comparison against visibility plane results (~4 months)
- Thesis writing and submission (~4 months)

The project can easily be extended to a full 24-month Masters by dissertation by including more clusters in the target sample.

Familiarity with Python is required. Experience with working with MeerKAT visibilities is advantageous.