Research Project Proposal

1. **Level**: Honours
2. **Name of primary supervisor**: Dr. Nikki Zabel
3. **Institution of supervisor**: SAAO (at the start of the project)
4. **Name of co-supervisor**: Dr. Sambatriniaina Rajohnson
5. **Institution of co-supervisor**: Osservatorio Astronomico di Cagliari
6. **Contact details of supervisor and co-supervisor**: nikki.zabel@uct.ac.za, sambatriniaina.rajohnson@inaf.it
7. **Project title**: "Using MeerKAT HI cubes to stack ALMA CO observations of dwarf galaxies in the Fornax cluster."
8. **Description of project**: The MeerKAT Fornax Survey is one of the eight key Large Survey Projects (LSPs) on the MeerKAT telescope. It has surveyed the neutral atomic hydrogen (HI) content in and around the entirety of the nearby Fornax galaxy cluster. Even since before the survey was completed, there have been ongoing efforts to combine these MeerKAT data with observations from other state-of-the-art instruments to study galaxy evolution in dense environments.

   One of these instruments is the Atacama Large Millimeter/submillimeter Array (ALMA). Being an interferometer, the data from this telescope are in principle similar to those from MeerKAT, but they have increased resolution and a smaller field-of-view because of the higher frequency range at which ALMA operates. ALMA was used in two different programmes to survey the molecular gas (traced by the CO(1-0) line) in Fornax galaxies. Molecular gas is an important ingredient to add to our picture of galaxy evolution, since it is the direct fuel for star formation. These surveys covered a number of dwarf galaxies, a large fraction of which were not detected. Now that we have HI detections of these galaxies from MeerKAT (and optical spectroscopy from SALT), we can utilise the velocity information from these observations to stack the ALMA non-detections, and try to get a combined detection for them. If we succeed, the resulting signal will be used to estimate the molecular gas mass in these low-mass systems, and their HI-to-H_2 ratios. These numbers may be included in a future paper, for which the student would be acknowledged as an author.

   The student will be given the fully reduced ALMA cubes containing CO non-detections, as well as the corresponding MeerKAT cubes with the HI detections. Using software provided by the supervisors, the student will combine these datasets in order to search for a stacked signal in the ALMA cubes. Depending on outcome and available time, we will try to obtain signals for each individual galaxy, or subsets of multiple galaxies at once. Spectral-line stacking is a technique widely used in the HI community. This project will teach the student to work with this valuable tool, and familiarise themselves with radio an millimetre interferometric data analysis.

   A basic understanding of interferometry data cubes is advantageous, but not required. The software that will be used for this project is Python-based, so basic knowledge of programming in Python will be needed.