7 February 2020

Please see the attached proposal for an MSc student.

Section A: Overview of the Research Project
1. Title of the research project
   Constraining Proclusters Using MeerKAT Data
2. Broad area of research (Engineering or Science)
   Science
3. Academic level of research project (Masters or Doctoral)
   Masters
4. Abstract of research project
   Regions where candidate proclusters have been identified from overdensities in submm images will be studied using one of the possible MeerKAT data, (1) target observations or (2) key or legacy surveys. Some of the MeerKAT data have already been obtained and reduced, while more can be obtained in the future as needed and opportunities arise.
5. Primary supervisor's details:
   a. Full name of primary supervisor
      Professor Lerothodi Leeuw
   b. Primary supervisor's email address (please note that if this project is approved, this email address will be made available to students to contact the primary supervisor)
      Lerothodi@alum.mit.edu
   c. University where primary supervisor is employed
      UNISA
6. Co-supervisor/Research supervisor's details (if relevant)
   a. Full name of co-supervisor/research supervisor
      Dr Dave Clements
   b. University where co-supervisor/research supervisor is employed
      Imperial College (UK)

Section B: Details of Research Project
1. Scientific/Engineering merit: describe the objectives of the research project, placing them in the context of the current key questions and understanding of the field.

   We have introduced a protocluster selection technique, combining Herschel/SPIRE images and Planck point source catalogues. Candidate protoclusters are selected from Planck point sources having Herschel source overdensities. Their FIR colours are consistent with a $z=0$ ULIRG redshifted to $z=2$-3. This technique is sensitive to dusty starbursts and dusty QSOs and currently approximately 30 candidate protoclusters have been found. Their FIR flux is greater than other optical-selected protoclusters at the same redshifts, such as using LBGs. Such excessive flux indicates that their member galaxies are undergoing a phase of dust enshrouded star-formation or AGN activity. This phase, although short, is important for understanding the stellar mass assembly of clusters. Since optical selection can miss the full protocluster population, only by comparing FIR- and optical- clusters can we understand the complete history of stellar mass assembly. Among our 30 candidate protoclusters, 6 have been awarded Spitzer/IRAC time for imaging in 3.6 and 4.5 micron.

2. Feasibility: outline the methods that will be used to achieve the objectives. Provide details on the availability of required data / access to required equipment / availability of research facilities and other resources required. Include any relevant expected intermediate milestones and associated timeframes towards attaining the overall objectives of the project.

   We have targeted and observed at least 3 candidates which have scheduled Spitzer observations and observable by MeerKAT. Using MeerKAT imaging at 1.38 GHz, and including the outer-ring antennae, we can localise the counterparts of the dusty starbursts in the protoclusters, owing to the FIR-radio correlation, and along with IRAC observations. SED modeling will provide SFRs, stellar mass, etc., will uncover details of the mass assembly of

University of South Africa
College of Graduate Studies
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone + 27 11 670 9703
Email leeuwll@unisa.ac.za
www.unisa.ac.za/cgs

these protoclusters. With modest observing time we can have an impact on cosmology, future SKA, JWST and WFIRST projects and showcase and involve students in early MeerKAT observations.

While some of the MeerKAT data have already been obtained and reduced, more can be obtained in the future as needed and opportunities arise.

3. Link the proposed project to one or more of the SARAO research priority areas for 2021 (refer to Section 5 of the Application Guide), and explain in some detail how the proposed research will contribute to the priority area(s).

    This project uses MeerKAT data and directly links with the SARAO research priority areas for 2021.

4. If relevant, describe any particular qualifications, academic abilities, skills and/or experience that a student should have in order to successfully deliver on the objectives of the research proposed.

Yours sincerely

Professor Lerothodi Leeuw
College of Graduate Studies
University of South Africa (UNISA)

Office +27 11 670 9703
Mobile +27 83 700 4145
Email Lerothodi@alum.mit.edu

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone + 27 12 429 8675 Facsimile + 27 12 429 3434
www.unisa.ac.za/cse

2