

Section A: Overview of the Research Project Proposal

1. Academic level of research project: **Doctoral**
2. Broad field of research: **Astronomy/Astrophysics**
3. Title of the research project: **Unveiling the formation of the large scale structure in the nearby Universe. The spectacular case of the Shapley Concentration**
4. Full names of supervisor and co-supervisor: **Prof Oleg Smirnov (Rhodes U.), Dr Tiziana Venturi (INAF-IRA, Italy)**
5. University where postgraduate student would be registered: **Rhodes University**

Section B: Research Project Proposal

Abstract: The Shapley Concentration is a unique test bed to study the mass assembly history and the formation of the Universe large scale structure. In this research proposal, the candidate will use GMRT and MeerKAT radio observations of two galaxy clusters to unveil the dynamics and star formation properties of the Shapley Concentration.

Scientific merit: The Shapley Concentration is a gold mine for the study of mass assembly through minor mergers. The central region of the Shapley Concentration consists of two large "cluster complexes", where clusters and groups are merging. It is thus the site where we can study large scale structure formation in action. The two complexes, referred to as the "A3558 complex" and the "A3528 complex" are expected to be in very different evolutionary stages, as suggested by the current observations, but the details of each are still unknown. Both cluster complexes have been observed with MeerKAT and with the uGMRT in Bands 3, 4 and 5. The two sets of observations are available for a PhD thesis, whose main goals are the following:

- a) Search for diffuse emission on the cluster scale in the A3558 complex and address the study of its evolutionary stage. Previous observations with lower sensitivity suggest the presence of a peripheral relic, which needs to be firmly classified;
- b) Study the emission of the dominant galaxies in the A3528 complex (A3528N, A3528S and A3532) and address the question of the origin of the extended radio emission, i.e. recurrent radio activity vs particle re-acceleration in the cluster core;
- c) Study the radio activity of galaxies in the two complexes down to the starburst radio powers for comparison of the role of cluster mergers and group accretion in the two complexes;
- d) Study the tailed radio galaxies in both complexes to infer details on the merger competing scenarios;

e) The combination of MeerKAT and uGMRT observations will allow detailed spectral studies of the radio sources of interest.

Feasibility: For both cluster complexes ancillary data are available from a large collaboration in the X-ray (Chandra and XMM) and in the optical (AAT, SDSS, ESO, Galex, Spitzer) bands. Finally, the mass distribution from the Planck satellite is available for the A3558 complex. GMRT and MeerKAT observations of both complexes have already been carried out.

Storage and computing resources for this project will be provided by the compute cluster of the Rhodes Centre For Radio Astronomy Techniques & Technologies (RATT).

Scientific supervision of the project will be provided by Dr Venturi (INAF-IRA, Italy), and technical supervision by Prof Smirnov (Rhodes). The student is expected to spend some time in Italy at INAF-IRA and Dr Venturi will pay regular visits to South Africa. The bilateral project of cooperation between Italy and South Africa (RADIO SKY 2020, within the ISARP framework), will be a potential source of funding for travel support for the first two years of the project. The supervisor will be able to provide further support until the end of the project.

Link to SRAO research priority areas for 2020: The proposed research project will exploit MeerKAT data awarded in the Open Time call for proposals issued in December 2018. It is therefore directly linked to the highest priority area of the call.

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: familiarity with radio interferometry and observational radio astronomy would be an advantage but it is not strictly required.