

PhD Supervisor: Prof. Paul Groot (UCT/SAAO/Radboud)
Email address: pgroot@ast.uct.ac.za, p.groot@astro.ru.nl
Registration: Student will be expected to register at the University of Cape Town (UCT)
Project Title: **Transient and Variables in Star Clusters**
Type: **MSc**, within the UCT/SAAO-based SARChI group of Paul Groot

Project Description

1 Problem Statement

Stellar evolution underlies much of our understanding of stars and galaxies. In particular due to the presence of binary and triple stars the possible pathways in the evolution of stars are myriad. Isolated stellar populations of a single (or limited range of) ages provide ideal environments to study stellar and binary evolution. However, this requires a comprehensive and homogeneous study of full star clusters with high quality data. Only now can this be provided by the MeerLICHT, BlackGEM and MeerKAT wide-field telescopes.

2 Aims and Objectives

The aim of the project is to study star clusters (open and globular) in their entirety to provide a comprehensive and complete study of variables and transients in these star systems. Using these high quality observations we will compare these populations to those predicted from binary population synthesis codes, to a) understand the evolution of the star clusters themselves (initial masses, compositions, mass-loss, mass segregation), as well as to constrain stellar evolution. Multiple systems with varying degrees of stellar density, age and metallicity will be studied to disentangle the effects caused by the initial conditions of the cluster, from those of the intrinsic evolution of stars and binaries.

The project will use data from the combined MeerLICHT+MeerKAT optical-radio studies and the BlackGEM optical data, within the SARChI group of Paul Groot and the ThunderKAT LSP project to identify transients and variables in star clusters. The MeerLICHT and BlackGEM telescopes are unique in their large field-of-view, coupled to high spatial resolution. This allows for the study of *full* clusters without any need for mosaicing or loosing the outer parts of the clusters.

Newly identified systems will be studied using the SAAO/SALT telescopes, the MeerKAT radio array, as well as the telescopes of the European Southern Observatory (VLT, NTT, ALMA) to

- a) understand their physical nature
- b) understand the influence of the initial conditions of the clusters
- c) constrain the myriad of pathways in binary stellar evolution.

The project will study the nearest star clusters most intensely. These include open and globular clusters in the Milky Way, the Magellanic Clouds, and the Local Group galaxies, such as the 1000+ globular clusters of the giant elliptical galaxy Centaurus A. It is out to these distances that with ground-based or space-based telescopes we can resolve individual stars. This will be of immense value as it may even lead to the detection of a progenitor system as well as allow for a deep long-duration study of the event and any late-time changes in their appearance.

Full advantage will be made of the unique time and colour-baseline of the MeerLICHT and BlackGEM telescopes, and the access South Africa has to cutting-edge astronomical facilities.

3. Potential Impact

The impact of this study is manifold:

- a) a better understanding of the population of variables and transients within a galactic population of stars

- b) the use of variables and transients to constrain binary evolution.
- c) the possible detection of absolutely unique transients, such as merger systems.

4. Alignment with National Imperatives

This project aligns with the following national imperatives:

- i) NRF Broad Category: Environmental, Material, Physical and Technology: Astronomy is a physical-technical discipline and strong usage will be made of cutting-edge technology in South Africa (MeerLICHT, SALT, SAAO telescopes) as well as globally (e.g. the telescope of the European Southern Observatory)
- ii) National Priority: Transformation: the training of transformed, science-and-technology based researchers is the basis of South Africa's future in the Fourth Industrial Revolution.
- iii) Grand Challenge: Astronomy: this project is astronomy, where usage is made of South Africa's cutting-edge technology to understand the Universe and our place in it.
- iv) Sustainability Goals: Quality Education. Astronomy is a STEM-discipline that forms the basis of the future development of South Africa and an educated population.

5. National Infrastructure Platforms:

SAAO, SALT, MeerLICHT, MeerKAT, IDIA/Ilifu