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Registration: Student will be expected to register at the University of Cape Town (UCT)
Project Title: **Modelling system parameters of Galactic Pulsating stars**
Type: **MSc**, within the UCT/SAAO-based SARChI group of Paul Groot

Project Description

1 Problem Statement
Our understanding of the structure and evolution of stars is largely based on *external* information: parallaxes, proper motions, luminosities, rotational periods etc. Very little is known on the *internal* consititution of stars, simply because we cannot look beyond the stellar photosphere/surface. This very much limits our understanding of the interior stars, which, ultimately drives the evolution of stars, simply because nuclear fusion takes place at the centre of the star. In understanding the evolution of stars we are left with large gaps on the role of convection, convective overshoot, differential internal rotation and internal mixing into the fusion core. However, a small set of stars does allow a look below the surface: pulsating stars, through the technique of asteroseismology. In these stars, pulsations are driven through internal processes, and, similar to earthquakes on Earth, the characteristics of the pulsations can be used to derive the internal structure of stars. We can therefore use pulsating stars to better understand the physical processes inside stars, as well as to use them as tracers of particular populations of stars.

2 Aims and Objectives
Using a multi-colour multi-telescope dataset, obtained with the MeerLICHT, BlackGEM, ATLAS, ZTF, TESS and Gaia instruments, we will construct a better understanding of the Galactic population of pulsating systems, in particular those that are currently post-main-sequence. Usage will be made of publicly available light curve modeling programs to model the light curve of pulsating systems and derive their system parameters and place them in the Galactic context of pulsators. Hundreds of pulsator light curves are currently already available so attention will be paid to the scalability of the modeling routines to large samples. The innovative aspect of our approach is in the number of systems, in combination with the multi-colour light curves available from wide-field synoptic surveys. This is a largely numerical study, using the facilities at IDIA/Ilifu to model the light curves already obtained with (inter)national facilities.

3. Potential Impact
The impact of this study is to better understand the internal structure and evolution of stars, which touches on all aspects of stellar astrophysics. As an example: the post-main sequence, pulsating subdwarf B-stars are the strongest UV emission sources in galaxies. Therefore, the understanding of the global properties of galaxies requires an understanding of post-main sequence pulsating stars. Also, the population of extreme binaries that are the progenitor population of supernovae, stellar mergers, gravitational wave sources and X-ray binaries have all gone through an episode of stellar pulsations. In addition, the population of certain types of stellar pulsators such as Cepheids and RR Lyrae stars can be used to trace the stellar content of the Galactic Halo, going back to pioneering work of e.g. Hubble who used them to establish the distance scale of the Universe.

4. Alignment with National Imperativesf
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 (MeerKAT, MeerLICHT, SALT, SAAO telescopes).
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, SARAO/MeerKAT, SALT, MeerLICHT, IDIA/Ilifu