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Registration: Student will be expected to register at the University of Cape Town (UCT)
Project Title: **The interior physics of pulsating variables**
Type: **PhD**, within the UCT/SAAO-based SARChI group of Paul Groot

Project Description

1 Problem Statement

The interior of stars remains extremely hard to study from the outside Universe. One of the few tools that allows us to peer into the depths of stars is asteroseismology. With this technique star-quakes are used in very much the same way as earthquakes to decipher the interior structure and composition of stars. During their evolution stars often cross zones in the Hertzsprung-Russell diagram where they are more prone to undergo stellar radial and non-radial pulsations. These are often caused by ionization zones inside the stars, and or the interaction between the stellar core and the outer envelope. Example stellar populations found in such 'instability strips' include RR Lyrae stars, β Cepheids, subdwarf B-stars (sdB) and ZZ Ceti stars.

New technological advances in both wide-field surveys as well as high-resolution spectrographs allow a much more systematic understanding of how the interior physics of stars changes as a function of their evolution and composition. Kepler, TESS and shortly Plato allow high-quality, uninterrupted time series from space, and ground-based facilities such as MeerLICHT and BlackGEM allow simultaneous multi-colour observations, which combined allow for (non-)radial pulsational mode identifications.

Through a number of wide-field synoptic surveys our knowledge of the Galactic population of pulsational variables is expanding rapidly. The MeerLICHT/BlackGEM set of telescopes, in combination with the Gaia satellite, TESS, Kepler and Plato has been providing a growing set of high quality, multi-colour observations of hundreds of pulsating systems.However, many of these systems remain 'anonymous' as they are not used for extracting system parameters through light curve modelling where this is needed to better understand the overall population and evolution in their entirety in the Milky Way.

2 Aims and Objectives

Using the multi-colour multi-telescope dataset we will construct a better understanding of the Galactic population of pulsating variables, in particular those that are currently post-main-sequence. Hundreds of 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 understand the interior of stars across their evolution and in diverse settings with respect to initial chemical composition, binarity and/or presence in clusters. Eclipsing systems are ideal for the wealth of information they provide, and their well-understood selection biases. The results of this study will feed into (binary) evolution models of the population of stars in our Milky Way Galaxy.

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 (MeerKAT, MeerLICHT, SALT, SAAO telescopes) and international facilities: TESS, Plato, ESO, Gaia

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