Photospheric parameters and pulsations in A stars

We propose an MSc by Research project to be held at the University of Central Lancashire (UCLan) in the UK. This project builds on UCLan – SALT links established over many years and will involve the student analysing data from SALT/RSS, SpUpNic on the 1.9-m telescope, and from NASA's Transiting Exoplanet Survey Satellite (TESS).

With the recent availability of large photometric datasets from both ground (e.g. SuperWASP) and space (e.g. TESS) surveys, the identification of pulsationally and rotationally variable A stars has been afforded a new lease of life. However, it is often the case that photometric data alone cannot be used to fully characterize the targets of interest, and as such large volumes of spectroscopic data are required to complete these studies. Furthermore, it is well known that different types of pulsating stars occupy restricted regions in diagnostic diagrams such as the Hertzsprung-Russel diagram. Accurately defining those regions can help to understand the conditions for pulsations. To that end, we have been systematically collecting spectroscopic data from telescopes at the Sutherland site of the SAAO of the photometrically interesting stars identified in the aforementioned surveys (see results from e.g., Holdsworth et al. 2014, MNRAS, 439, 2078 & Sikora et al. 2019, MNRAS, 487, 4695), to shed light on the pulsation driving and mode selection in A stars, and confirm the spotted nature of candidate chemically peculiar A (Ap) stars. The pulsating A star type is particularly important for understanding stellar structure in a region of the HR diagram where internal changes from a radiative to convective core occurs, and thin convective hydrogen surface layers emerge. Such phenomena are directly probed with asteroseismology techniques.

The aim of this project is to bring together two strands of observational data, photometric and spectroscopic, to measure the main stellar photospheric parameters of candidate pulsating and Ap stars. Using new theoretical stellar libraries and fitting software, atmospheric parameters will be estimated in a large sample of spectra obtained from Sutherland telescopes. The observed stars are selected as candidate Ap or pulsating A stars, but their surface temperatures, gravities and abundances need to be measured to help make this assessment of what these stars are. Such a variety of data sources will also enable the study of candidate selection effects, given the various selection criteria of our observed samples of stars.

The stellar parameters will be estimated with the widely used fitting software FERRE, applied with new stellar spectral libraries, created at UCLan for stellar population analysis (Knowles, Sansom et al. 2021, MNRAS, 504, 2286; García Perez et al. 2021, MNRAS, 505, 4496). With these tools the student will be able to measure effective temperatures, metallicities and surface gravities of the stars, and plot them on Hertzsprung-Russell and related diagrams. Measurements of systematic errors will be undertaken, which dominate the uncertainties for these high signal-to-noise observed spectra. The results will provide new information for assessing properties of different types of A stars and where they are found in important diagnostic diagrams. The student would be provided with a Linux computer on-campus, and the software and reduced spectra to carry out this project. A successful outcome would lead to publication of the results and presentation at a research meeting, such as the UK's National Astronomy Meeting.

The proposed supervisory team would consist of Dr. Daniel Holdsworth, who is an expert on pulsations in stars and Dr. Anne E. Sansom, who is an expert in the analysis of stellar populations. Both are based in the Jeremiah Horrocks Institute for research, within the University of Central Lancashire.