Optical & near-Infrared variability in Be/X-ray binaries

Supervisor: Dr. Lee Townsend; Contact: lee@saao.ac.za
Potential co-supervisors: Dr. Itumeleng Monageng (SAAO/UCT)
Requirements: Honours degree in astronomy; proficiency in Python; experience with optical data analysis & handling FITS files

Student should be registered at UCT, but will work primarily from SAAO.

Project context

Be/X-ray binaries are one of the largest known groups of interacting binary star system and are thought to be direct progenitors of double-compact object binaries that emit gravitational wave radiation at the end of their lives, making these systems hugely important in our understanding of stellar and binary evolution. The donor Be stars in these systems are rapidly rotating, such that a "decretion" disc is formed as part of the stellar photosphere approaches the escape velocity of the star. Very little is known about these discs, though they are key in fully understanding how this large population of binaries form, interact and evolve, and how they feedback into the local galactic environment.

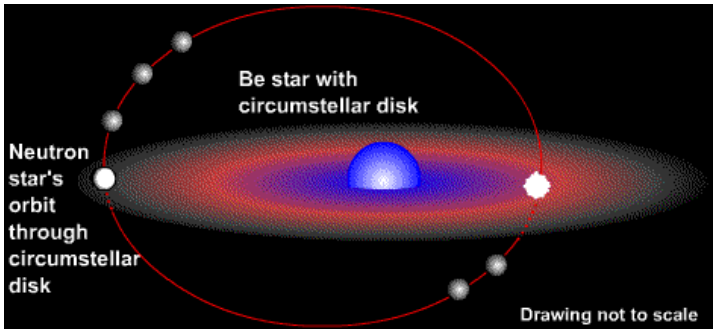

Figure 1: *A simple artist impression of a Be/X-ray binary. The neutron star orbits the Be star, interacting with the circumstellar disc.*

Project Description

The compact object (mostly a neutron star in these systems) orbits the Be star, often interacting with the decretion disc as it passes through or close by. This interaction produces X-rays, as material is accreted from the disc onto the compact object. However, this is not the only interesting result of the interaction. Being cooler than the stellar photosphere itself, decretion discs in Be/X-ray binaries emit strongly in the red and infrared. The proximity of the compact object causes material in the disc to be disturbed, resulting in flaring at red and infrared wavelengths. A large amount of information can be gained by studying this optical and infrared variability.

We have a number of ongoing & potential projects related to variability in Be/X-ray binaries. Our work focuses specifically on using SALT spectroscopy, optical photometry from survey instruments and X-ray all-sky monitoring data, to explore their behaviour. Possible projects include (but not limited to):

- Long-term spectral variability from 12+ years of SALT observations. This long baseline is rare for optical spectral data-sets and we expect a number of new insights to come from this data.
- Using near-infrared (NIR) observations from IRSF and SALT's new NIRWALS spectrograph to investigate variability at the (cooler) extremities of the disc, where little is known about how the compact object accretes and distorts the disc.
- Polarised emission from Be/X-ray binaries, using both IRSF polarimetry and SALT/RSS spectro-polarimetry.

Students should have a strong interest in observational/stellar astronomy, as this project is data intensive. They should also have a good understanding of Python and basic data analysis techniques. Previous experience with optical/NIR data reduction is advantageous. There will be opportunities for students to acquire their own datasets from Sutherland to supplement the data/projects described here.
An overview of the physics and observational characteristics of Be/X-ray binaries can be found here: https://arxiv.org/abs/1101.5036