Honours/MSc project: Long-term optical monitoring of Be-white dwarf binaries with SALT and MeerLICHT

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Project context and summary

Although stellar evolution models suggest a significant population of Be stars with white dwarf (WD) companions, observing these white dwarfs in binaries remains challenging. In the Magellanic Clouds, where there is low absorption, a group of transient or recurrent luminous supersoft X-ray sources has been uniquely identified with Be stars.

We plan to combine the available photometric data from MeerLICHT with precise spectroscopic measurements of variations over time in equivalent width, radial velocity, full width at half maximum of prominent emission lines (usually Hα and Hβ), and the flux ratio of the red and blue peaks of these double-peaked lines, which often exhibit a complex and changing structure. Once we have constrained the orbital period, we hope to measure the weak He I lines formed near the WD and the Be absorption lines by adding spectra taken at approximately the same orbital phase.

Previously, OGLE photometry indicated orbital periods of approximately 21.5 days for Swift J004427 (Coe et al. 2020) and roughly 17.4 days for Swift J011511 (Kennea et al. 2021). These are more recent discoveries not included in the paper by Cracco, Orio, Ciroi et al. (2018). Initial sparser data for the two XMM sources suggested long periods of about 1265 days for XMMU J010147 and approximately 640 days for XMMU J052016. These periods are unusually long for Be X-ray binaries, and preliminary analysis of MeerLICHT light curves indicates that these are likely super-orbital periods (see Rajolelimanana et al. 2011), while the actual orbital period for these two targets may be on the order of a few weeks.

The MeerLICHT photometry also shows variations in optical flux and colors (with changes of nearly half a magnitude in Suzaku J0105), making it difficult to track short-period orbital variations using data collected over many months and years. For this reason, we have improved the observation cadence to obtain better measurements of the radial velocity variation of Hα and Hβ (averaging 110±30 km/s for Swift J004427 and up to 200 km/s for other targets) and of their equivalent widths in 2023-2024, with observations every 5-8 days. The goal is to obtain a time base of several weeks for at least the four most promising sources.