## Discovery and Characterization of Cataclysmic Variables with LSST and SALT Spectroscopy

**Background and motivation:** Cataclysmic variables (CVs) are the primary source for most of the hard X-ray emission in our Galaxy, whether from the Galactic ridge or the central regions of the Milky Way. These are semi-detached interacting binaries containing a magnetic white dwarf (WD), which accretes material from a Roche-lobe filling late-type main sequence star. The various subclasses of CVs differ from each other in terms of light curve morphology, brightness variation, magnetic field strength, and variability timescales (Warner, 1995). Magnetic CVs are particularly intriguing due to their unique accretion mechanisms governed by the magnetic field of the WD. The special category of CVs, such as novae and dwarf novae, brighten by several orders of magnitudes during their outbursts and allow the discovery of these systems that are generally very faint in quiescence. CVs provide a natural scaled-down laboratory for accretion processes occurring in more extreme systems like active galactic nuclei or black hole/neutron star binaries, enabling tests of accretion disc models. Further, understanding the evolution of CVs can provide insights into the possible progenitors of type Ia supernovae. In some cases, where CVs can evolve into compact binary systems composed of two white dwarfs, these systems might be sources of gravitational waves when they merge (Scaringi et al., 2023, MNRAS).

**Project aim and objectives:** In the last few years, numerous all-sky surveys, such as the Catalina Real-time Transient Survey, the Zwicky Transient Facility, etc., have been successful in discovering many new CVs (Drake et al., 2014, MNRAS; Szkody et al., 2020, AJ). However, the current census of CVs is still very limited, especially in the southern sky, but this is expected to change in the next few years with the Rubin Observatory's Legacy Survey of Space and Time (LSST). LSST monitoring will significantly increase the CV sample by providing time-series data in optical ($ugrizy$) filters. The host is one of the IUCAA PIs of the LSST Transients and Variable Star (TVS) Science Collaboration, leading an in-kind software contribution developing software, algorithms, and pipelines for identifying and classifying variable and transient sources, including CVs and their follow-up spectroscopic observations. The participant is expected to be involved in utilizing existing datasets of CVs and plan their follow-up observations with SALT through joint access from South Africa and IUCAA. Through the host, the participant will also have access to follow-up and complementary observations at multi-wavelength facilities, such as GMRT and AstroSat.

The immediate objectives for the participant in this project are to explore various science cases, in particular, time-resolved high-resolution spectroscopy of the existing CV sample (Ritter & Kolb, 2003, A&A) using SALT. The current sample consists of 'quiescence' as well as 'outbursting' CVs. Doppler Tomography can be used to understand the system structure from phase-resolved emission lines from SALT spectra. It will provide crucial information, such as the origin of emitting regions, which could be WD, hot-spot, and secondary. Doppler maps help constrain the accretion disc structure, including the system's orbital parameters, mass ratio, and inclination angle (Echevarría, 2012). The same sample will also be observed by the 1.9-m telescope of SAAO for photometric and polarimetric observations, providing a unique opportunity for simultaneous and/or quasi-simultaneous studies of targets. These objectives will perfectly complement the goal of discovering and characterizing the CVs with the upcoming LSST data and through their follow-up high-resolution spectroscopy using SALT.

**Activities and Expected Outcome:**

1. The host, an expert in analyzing high-resolution spectra, already has observational programs on SALT and will facilitate a transfer of knowledge to the participant. The participant will have the opportunity to work with the already collected data to get familiarized with the data reduction process and explore various tools for data analysis.
2. The participant will have the opportunity to contribute to LSST TVS science collaboration, either through direct contributions to the ongoing software in-kind contributions on data reduction or through developing pipelines to identify and classify such variable sources and their spectroscopic follow-up.
3. By providing the participant access to IUCAA's computational and observational facilities, this program will enhance collaboration between IUCAA and SAAO/SALT, paving the way for similar future endeavours.
4. The host institute, IUCAA, will provide full local hospitality for two one month-long visits (or one visit up to two months) each year to the participant.