MeerLICHT Transients: Search for Historical Transients in the LMC and SMC

Background

The study of time-domain astronomy has entered a transformative era with wide-field optical surveys such as MeerLICHT, which provide high-cadence, deep imaging of the southern sky. These surveys enable the discovery and characterisation of transient and variable sources across a wide range of astrophysical phenomena, including novae, dwarf novae, supernovae, flare stars, and other eruptive systems.

The Large and Small Magellanic Clouds (LMC and SMC) are nearby satellite galaxies of the Milky Way, located at distances of ∼50–60 kpc. Their proximity, low extinction, and well-constrained distances make them ideal laboratories for studying transient populations in an extragalactic environment. Unlike Galactic studies, where distance uncertainties can be significant, transients in the Magellanic Clouds allow for accurate luminosity measurements and population studies.

MeerLICHT has accumulated several years of archival observations of the LMC and SMC. Now, with the recent reprocessing of archival data using the newest version of BlackBOX/ZOGY, we are presented with a unique opportunity to search for historical transient events that were not identified in real time but are recoverable through retrospective analysis. Such searches may uncover missed novae, dwarf nova outbursts, long-timescale variables, and rare transient phenomena, contributing to a more complete census of transient populations.

Project Outline

In this project, the student will perform a systematic search for historical transient events in the LMC and SMC using archival MeerLICHT data. This will involve accessing and working with MeerLICHT imaging data and/or light curve products, and identifying transient candidates through variability analysis and/or image differencing techniques. The student will construct and analyse light curves of candidate sources, cross-match these candidates with existing catalogues (e.g. Gaia, SIMBAD, and TNS), and classify the transients based on their photometric behaviour. Where possible, identified transients will also be cross-correlated with archival MeerKAT radio data to investigate potential radio counterparts.

Objectives

The primary objectives of the project are to retrieve and organise MeerLICHT data, identify transient candidates, and analyse their light curves in terms of timescales, amplitudes, and colours. The student will further aim to classify the detected sources (e.g. novae, dwarf novae, flare stars) and interpret the results within the broader context of transient populations in the Magellanic Clouds. Through this work, the student will gain experience in time-domain astrophysics, data analysis, and observational techniques.

Methods

The student will use a combination of computational and observational data analysis techniques. This will include programming in Python (using packages such as NumPy, Pandas, Matplotlib, and Astropy), handling astronomical data products such as FITS images and catalogues, and performing time-series analysis to extract and quantify variability in light curves. In addition, cross-matching with astronomical databases (e.g. Gaia, SIMBAD, and TNS) will be used to identify and contextualise sources. Where available, archival MeerKAT data will be used to search for radio counterparts to the identified transients. For more advanced approaches, the project may also incorporate image

subtraction techniques and, where appropriate, machine learning or statistical filtering methods for transient detection.

Requirements

Basic Python skills, familiarity with Linux (advantageous), and access to a laptop.

Supervision

Supervisor: Prof. Paul Groot (UCT/Radboud)
Co-supervisors: Moses Mlangeni (UCT/SAAO), Lloyd Landsberg (UCT/SAAO)