Cir X-1, the Africa nebula: Exploring the MeerKAT time-series of the youngest known X-ray binary

1 Supervision

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2 Project background and objective

Circinus X-1 (hereafter Cir X-1) is the youngest known ($t < 4600$ yrs) neutron star X-ray binary (NSXB). The nebula was recently named the Africa nebula featuring in NASA's astronomy picture of the day. Although initially discovered in 1971 as a black hole X-ray binary, Cir X-1 was later found to have Type I X-ray bursts in 1985. These bursts were later confirmed by the RXTE detection in 2010, hence the NSXB classification. The source has been observed to show varying X-ray colour ratios over the durations of the outburst, thus it is known as both an Atoll and a Z-source. Cir X-1 has extensive jets within the nebula and has re-occurring outbursts every 16.5 days.

Cir X-1 was the subject of a large radio monitoring campaign at 1.28 GHz (L-band) within MeerKAT's Large Survey Programmes, ThunderKAT. The monitoring campaign occurred in 2021 during which the source was observed daily between 3 August to 5 September 2021 such that two full oburst cycles were covered. During this period the Swift XRT telescope performed quasi-simultaneous observations as part of (SwiftKAT) the ThunderKAT/Swift collaboration. The objective of this project is to determine the time-series results of the radio and X-ray data. Furthermore, investigate the day to day variability of the source through the difference images.

3 Required Tools

The student will require an IDIA Ilifu account for radio imaging with the semi-automated Oxkat pipeline. XSPEC installed on local machine for X-ray spectral fitting of the XRT data to determine the X-ray flux values. CASA installed on local machine to extract the radio flux values.

4 Expected outcome

At the end of the project the student will have a basic understanding of X-ray binary systems and the aspects of analysis for both radio and X-ray wavebands. The student will know how to process and image MeerKAT data and fit X-ray spectra. Cir X-1 is a perculiar object with numerous unexpected characteristics, the analysis of this source contributes to the universal understanding of jet systems for black hole and neutron star X-ray binaries. Therefore, performing very impactful science.