

Time-domain studies of compact binaries

Background

Cataclysmic variables (CVs) are semi-detached compact binaries consisting of a white dwarf (WD) and a low-mass main-sequence star – usually a red-dwarf (Warner, 1995). The close proximity of the two stars allows matter (gas) to be transferred from the red dwarf to the WD via a Roche lobe overflow. CVs offer astronomers a laboratory to study a wide range of phenomenon including the physics of accretion onto compact objects such as WDs, the formation and evolution of close binaries. Their rapid variability on a variety of time scales (e.g. from a few seconds to decades) allow us to study and understand their long and short time scales variabilities which are directly linked to the variation in mass transfer from the companion star to the WD. CVs are classified according to a wide range of properties including outbursts, photometric and spectroscopic properties, and sometimes CVs are divided into two groups, magnetic CVs and non-magnetic CVs. The non-magnetic CVs group includes dwarf novae (DNe) and nova-likes and these are generally disc-dominated systems which shows a wide range of behaviour such as dwarf nova outbursts, superoutbursts, standstills and super-humps. The magnetic CVs (mCVs) are divided into polars (Tapia, 1977) and the intermediate polars (IPs; Patterson 1994). The classification into polars and IPs is based on the magnetic field strength of the WD amongst others properties. For example, the WD in polars have strong magnetic fields ranging 7–230 MG (see e.g. Wickramasinghe & Ferrario, 2000) – which prevent the formation of an accretion disc, and the WD and the companion star in polars are locked together in synchronous rotation (Frank et al., 1992). The field strength of the WD in IPs range from 1 to 10 MG (e.g. BG CMi, Chamugam et al. 1990) – and is strong enough to disrupt and/or truncate the inner part of the accretion disc which is formed around the WD. One of the defining characteristics of IPs is that their WDs rotate rapidly and their spin period is always less than or a fraction of the binary’s orbital period.

RXJ1313.2–3259 was identified as one of the brightest X-ray source in the ROSAT programme (Voges et al., 1999). It was one of those source detected at high galactic latitudes (Thomas et al., 1998) and has an orbital period of 4.19 h (Thomas et al., 2000). Gänsicke et al. (2000) found this system to be a low-accretion rate AM Her systems which makes it ether a new CV or an old CV in a prolonged state of accretion. RXJ1313–3259 is located at a distance of 200 pc and its magnetic field strength, determined from cyclotron modelling, is 56 MG. Recently, Barrett et al. (2020) presented radio observations of RXJ1313–32 with the VLA and was found to have a flux density of $20 \pm 5 \mu\text{Jy}$. In addition, RXJ1313–3259 show 100% circular polarization and this is consistent with electron cyclotron maser emission. They estimated the coronal field strength of the secondary star to be $3563 \pm 730 \text{ G}$ for this source.

Project outline

In this project, student(s) will engage in the comprehensive reduction and analysis of photometric and polarimetric observations of RXJ1313–3259, utilizing data collected from the South African Large Telescope (SALT) and the 1.9-m and 1.0-m telescopes at the South African Astronomical Observatory (SAAO). The student(s) will conduct an in-depth time-series analysis of the target to scrutinize the dynamic nature of this system.

Requirements

Basic Python coding and familiarity with the Linux environment are a must. Access to a laptop is required.

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