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Notice for the PhD Viva-Voce Examination

Mr Rikame Ketan Bhaskar, Registration Number: 1981201, PhD Scholar at the School of Sciences, CHRIST (Deemed to be University), Bangalore will defend his PhD thesis at the public viva-voce examination on Thursday, 15 May 2025 at 2.00 pm in Room No. 044, Ground Floor, Research and Development Block, CHRIST (Deemed to be University), Bengaluru - 560029.

Title of the Thesis	:	**Timing, Spectroscopy and Polarimetry Studies of X-Ray Binary Systems**
Discipline	:	**Physics**
External Examiner - I	:	**Dr Sachindra Naik** Professor Astronomy and Astrophysics Division Physical Research Laboratory Ahmedabad - 380009 Gujarat
External Examiner - II	:	**Dr Vivek Kumar Agrawal** Scientist - SF Space Astronomy Group, SSIF, ISITE Campus U. R. Rao Satellite Centre (URSC) Karthiknagar, Outer Ring Road Bengaluru – 560037 Karnataka
Supervisor	:	**Dr Jithesh V** Associate Professor Department of Physics and Electronics School of Sciences CHRIST (Deemed to be University) Bengaluru - 560029 Karnataka
Co-Supervisor	:	**Dr Biswajit Paul** Professor Department of Astronomy and Astrophysics Raman Research Institute Bengaluru - 560080 Karnataka

The members of the Research Advisory Committee of the Scholar, the faculty members of the Department and the School, interested experts and research scholars of all the branches of research are cordially invited to attend this open viva-voce examination.

Registrar

Place: Bengaluru
Date: 08 May 2025

ABSTRACT

X-ray binaries (XRBs) rank among the most luminous X-ray sources in the sky. They consist of a compact object gravitationally bound to a normal companion star, with the compact object being either a neutron star or a black hole. The immense energy output of XRBs arises from the accretion of matter onto the compact object. As material falls inward, its gravitational potential energy is transformed with remarkable efficiency into high-energy radiation, driven by mechanisms like blackbody radiation and inverse Compton scattering. In some cases, the neutron star can possess an extremely strong magnetic field of the order 10^{12} Gauss. Such strong magnetic fields guide ionized material along magnetic field lines toward the neutron star's magnetic poles, forming accretion columns that emit pulsed X-rays. Due to their extreme gravity near the compact star and intense magnetic fields, in some cases, XRBs serve as natural laboratories for studying extreme physical conditions.

This thesis focuses on the timing, spectroscopy, and polarimetry studies of various X-ray binary systems to improve understanding of their accretion processes, emission mechanisms and reprocessing environment. The first study reports the discovery of transient quasi-periodic oscillations (QPOs) in the high-mass X-ray binary pulsar LMC X-4, enabling an indirect estimation of its magnetic field strength in the absence of Cyclotron Resonant Scattering Features. The second study investigates the reprocessing environment in high-mass X-ray binaries by analyzing eclipse flares in sources such as Vela X-1, LMC X-4, and 4U 1700-37. In 4U 1700-37, we detected a soft excess in the spectrum whose flux does not vary between eclipse flare and non-flare states. Our analysis suggests that this emission originates from the extremely thin shell of the stellar wind surrounding the photosphere of the companion star. The third study explores eclipse bursts in the low-mass X-ray binaries EXO 0748-676 and XTE J1710-281. We estimate the reprocessing efficiencies in both systems at various orbital phases by modeling the peculiar eclipse bursts, which exhibit tails extending beyond the eclipses. X-ray polarimetry is a relatively new area of research and offers unique insights into anisotropies within celestial systems. The thesis includes results from the Indian X-ray polarimeter (POLIX) onboard XPoSat, focusing on detector calibration, energy-dependent response, and data selection strategies to optimize the signal-to-noise ratio, particularly for faint X-ray sources. With results from timing and spectroscopy analyses, together with POLIX polarimetry data, this thesis aims to provide a comprehensive understanding of X-ray binary systems.

Keywords: X-rays: binaries, (stars:) pulsars: general, stars: neutron, X-rays: individual: LMC X-4, Vela X-1, 4U 1700-37, EXO 0748-676, XTE J1710-281, Polarimetry-Instrumentation

Publications:

1. **Rikame, Ketan**; Paul, Biswajit; Pradhan, Pragati; Paul, K. T. Discovery of quasi-periodic oscillations in the persistent X-ray emission of accreting binary X-ray pulsar LMC X-4 *Monthly Notices of the Royal Astronomical Society*, Volume 512, Issue 4, pp. 4792–4797 (June 2022). DOI: 10.1093/mnras/stac729, arXiv: 2203.07981
2. **Rikame, Ketan**; Paul, Biswajit; Sharma, Rahul; Jithesh, V; Paul, K. T. Flares during eclipses of high-mass X-ray binary systems Vela X-1, 4U 1700-37, and LMC X-4 *Monthly Notices of the Royal Astronomical Society*, Volume 529, Issue 4, pp. 3360–3371 (April 2024). DOI: 10.1093/mnras/stae739, arXiv: 2403.05936
3. Sharma, Rahul; Jain, Chetana; **Rikame, Ketan**; Paul, Biswajit Broad-band mHz QPOs and spectral study of LMC X-4 with AstroSat *Monthly Notices of the Royal Astronomical Society*, Volume 519, Issue 2, pp. 1764–1770 (February 2023). DOI: 10.1093/mnras/stac3572, arXiv: 2212.01003