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Highs, Lows, and Flares: A Polarized View of Shocks and Outflows in PSR J1023+0038

Transitional millisecond pulsars (tMSPs) bridge the gap between accreting neutron stars in low-mass X-ray binaries and millisecond radio pulsars, offering a unique laboratory to study the interplay between accretion and pulsar activity. These systems exhibit a subluminous X-ray state characterized by alternating high, low and flaring emission modes.
Multi-wavelength campaigns on the prototype tMSP, PSR J1023+0038, have helped establish a solid understanding of how tMSPs are powered. A complex interplay between a compact jet, discrete ejecta, accreting matter and the pulsar wind seem to be regulating the behaviour of this puzzling source.
Recently, using polarimetric data from the Imaging X-ray Polarimetry Explorer (IXPE), the Very Large Telescope (VLT), and the Karl G. Jansky Very Large Array (VLA), we conducted the first multiwavelength polarimetric study of PSR J1023+0038.
A linear polarization of (12±3)% in the 2–6 keV band was observed during the high mode. The polarization angle aligns with the optical polarization observed by the VLT, suggesting a shared physical mechanism. During the low mode, the significance was insufficient for detailed analysis, resulting in an upper limit of 26% (90% confidence) on the polarization degree. The results strongly indicate that both optical and X-ray polarization originate from synchrotron radiation at the shock formed by the interaction of the pulsar wind with the inner accretion disc.
Finally, simultaneous radio, optical, and X-ray observations obtained as part of this campaign have, for the first time, shed light on the poorly understood flaring mode emission, emphasizing the critical role of outflows in tMSPs.

Contribution

Oral talk

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