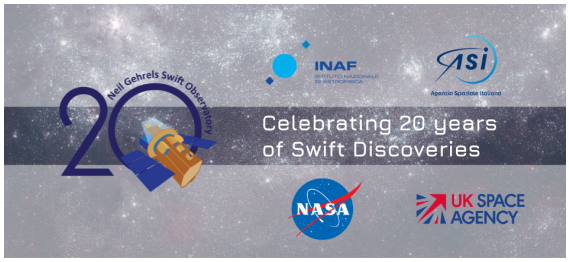

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The physics behind the emission modes in the transitional millisecond pulsar PSR J1023+0038: insights from IXPE, Swift, VLT and VLA

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Transitional millisecond pulsars (tMSPs) bridge the evolutionary 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 distinctive subluminous X-ray state characterized by alternating high, low and flaring emission modes.
Swift/XRT has always had a key role in identifying mode transitions in the prototype tMSP, PSR J1023+0038. Recent multi-wavelength campaigns (including Swift/XRT) on the source have helped establish a solid understanding of how tMSPs operate and are powered.
More 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), together with mode-monitoring observations from Swift/XRT, we conducted the first multiwavelength polarimetric analysis 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.

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