Astronomers investigate the nature of a bright low-mass X-ray binary system

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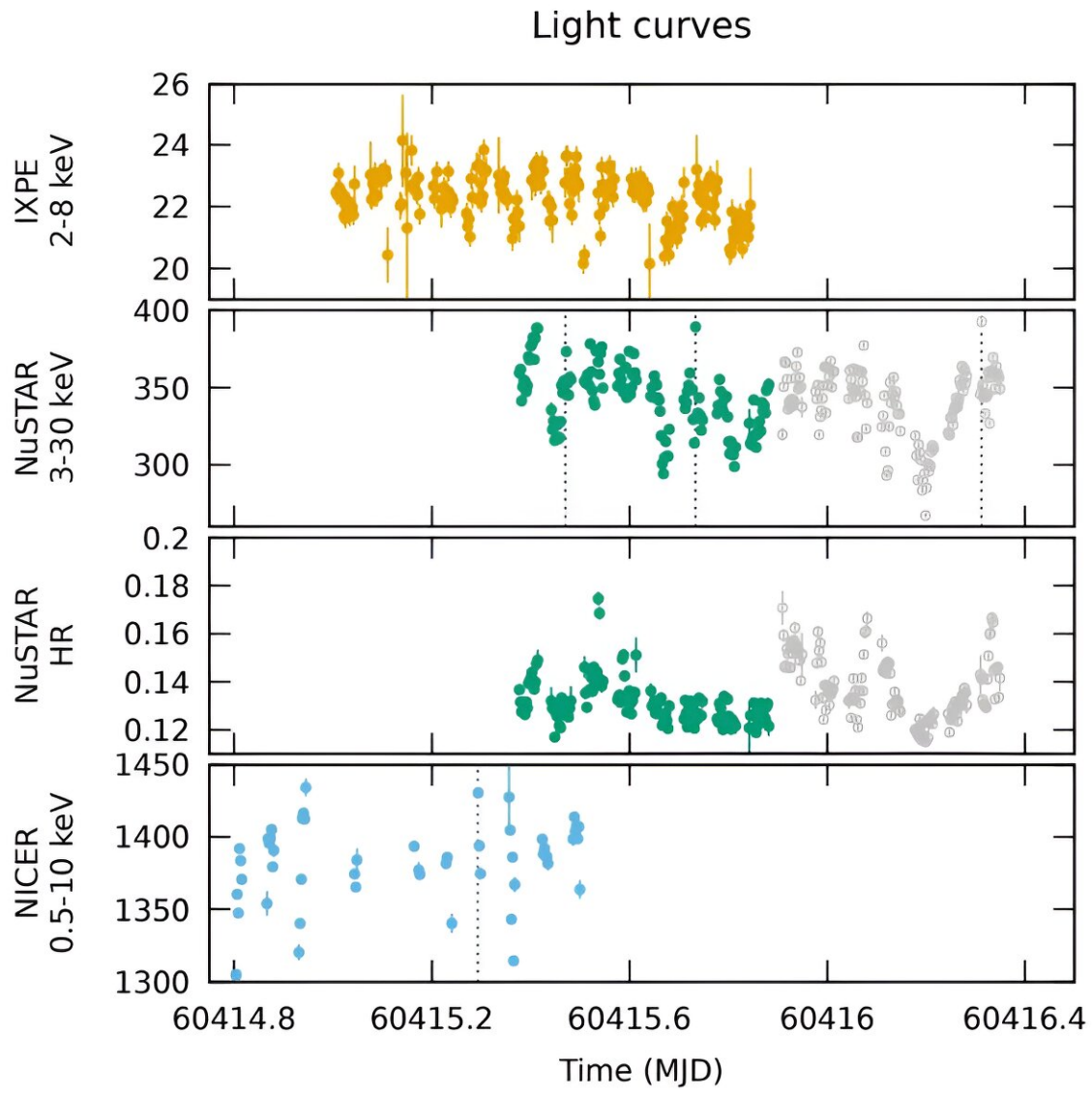

IXPE, NuSTAR, and NICER light curves of Serpens X-1. Credit: Ursini et al,

Using various space observatories, astronomers have performed X-ray polarimetric and spectral observations of a bright low-mass X-ray binary known as Serpens X-1. Results of the observational campaign, published August 29 on the preprint server *arXiv*, provide important insights into the nature of this system.

X-ray binaries (XRBs) are composed of a normal star or a white dwarf transferring mass onto a compact neutron star or a black hole. Based on the mass of the companion star, astronomers divide them into low-mass X-ray binaries (LMXB) and high-mass X-ray binaries (HMXB).

Neutron star (NS) LMXBs are further divided into atoll and Z sources. The so-called atoll-type systems share some characteristics with black hole LMXBs as they have similar X-ray spectra and timing properties. However, they differ in their radio properties, in that atoll sources are 27 times less radio luminous.

Located some 25,000 light years away, Serpens X-1 (or Ser X-1 for short) is a bright, persistent atoll NS LMXB. It is a well-studied source, consistently observed in the high luminosity, soft spectral state, with a luminosity of about 67 undecillion erg/s. All in all, Serpens X-1 is one of the X-ray-brightest atolls known to date and therefore it is an excellent target for X-ray polarimetry.

That is why a team of astronomers led by Francesco Ursini of the Roma Tre University in Rome, Italy, decided to conduct such studies of Serpens X-1 and also its spectral observations, using the Imaging X-ray Polarimetry Explorer (IXPE), the Neutron Star Interior Composition Explorer (NICER) and Nuclear Spectroscopic Telescope Array

(NuSTAR).

The observations found that the X-ray polarization degree for Serpens X-1 is less than 2.0% in the 2–8 keV energy band. This can be due to the low inclination angle (approximately 25 degrees) of the source.

Furthermore, the observations detected four type I X-ray bursts from Serpens X-1, with properties that are consistent with previous studies. The astronomers noted that this is the first time that IXPE has identified type I X-ray bursts. The upper limit to the burst polarization was found to be 80%.

The study also confirmed the presence of a relativistic reflection component in the X-ray spectrum—a broad iron line. The researchers found that this iron line requires an iron abundance of about five times the solar one, which is consistent with previous estimates.

Summing up the results, the authors of the paper concluded that the obtained polarization and spectral properties of Serpens X-1 are, in general, comparable to other atoll-type neutron star low-mass X-ray binaries investigated with IXPE. This suggests similar geometry of Serpens X-1 to these systems.

More information: F. Ursini et al, X-ray spectropolarimetry of the bright atoll Serpens X-1, *arXiv* (2024). DOI: 10.48550/arxiv.2408.16713