Ultraluminous X-ray pulsar M51 ULX-7 inspected by researchers

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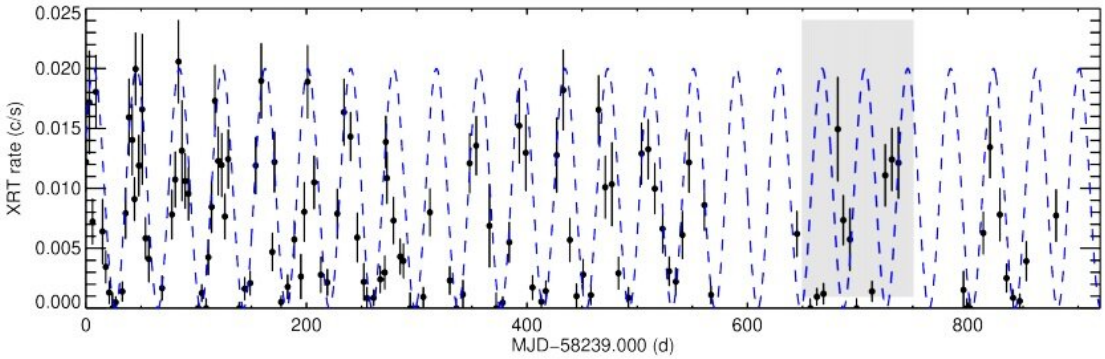

X-ray light curve of M51 ULX-7 based on the 2018-2020 Swift/XRT monitoring of the region. Credit: Vasilopoulos et al., 2021.

Using NASA's Swift and Chandra space observatories, astronomers have investigated an ultraluminous X-ray pulsar known as M51 ULX-7. The study, detailed in a paper published February 16 on the arXiv pre-print server, sheds more light on the X-ray variability of this source.

Ultra-luminous X-ray sources (ULXs) are point sources in the sky that are so bright in X-rays that each emits more radiation than 1 million suns

emit at all wavelengths. Although they are less luminous than active galactic nuclei, they are more consistently luminous than any known stellar process.

Astronomers generally believe that due to their brightness, most ULXs are black holes. However, recent observations have found that some ULXs showcase coherent pulsations. These sources, known as ultra-luminous X-ray pulsars (ULXPs), are neutron stars typically less massive than black holes. The list of known ULPs is still relatively short; thus, studying objects of this class is essential for researchers exploring the universe in X-rays.

M51 ULX-7 is a ULXP hosting a neutron star rotating with a spin period of about 2.8 seconds. It is a binary system with a period of approximately two days, exhibiting a super-orbital modulation with a period of some 38 to 39 days. A team of astronomers led by Georgios Vasilopoulos of Yale University took a closer look at the super-orbital and orbital variability of M51 ULX-7 by analyzing archival Chandra and Swift data.

"We studied the variability of M51 ULX-7, the only ULXP with an orbit that can be continuously monitored by X-ray observatories," the astronomers wrote in the paper.

The observations show that M51 ULX-7 was in an extended low-flux state. The astronomers suppose that the observed state might be related to a propeller transition or it could indicate a variable super-orbital period like those in other accreting pulsars.

Furthermore, the study detected periodic dips in the Chandra X-ray light curve of M51 ULX-7. They are associated with the binary orbital period. This is the first time when such dips have been identified in a ULXP.

The astronomers added that the physical origin of these dips remains unclear; however, it suggests a configuration where the orbital plane of the binary system is closer to an edge-on orientation.

The results suggest that the mass accretion rate in M51 ULX-7 is super-Eddington. The findings allowed the team to calculate that the binary orbit should change approximately 0.3 seconds per year.

In concluding remarks, the authors of the paper noted that their research underlines the need for further studies of ULXPs, especially long-term monitoring of such sources.

"From an observational point of view, it demonstrates the need for long monitoring observations of ULXPs and ULXs to identify and confirm the presence of features related to orbital modulation. Such combined efforts would help to develop a physically motivated, self-consistent model able to explore the central engines of ULXPs," the scientists concluded.

More information: Chandra probes the X-ray variability of M51 ULX-7: evidence of propeller transition and X-ray dips on orbital periods, arXiv:2102.07996 [astro-ph.HE] arxiv.org/abs/2102.07996