Astronomers examine the behavior of quasi-periodic eruptions in the galaxy GSN 069

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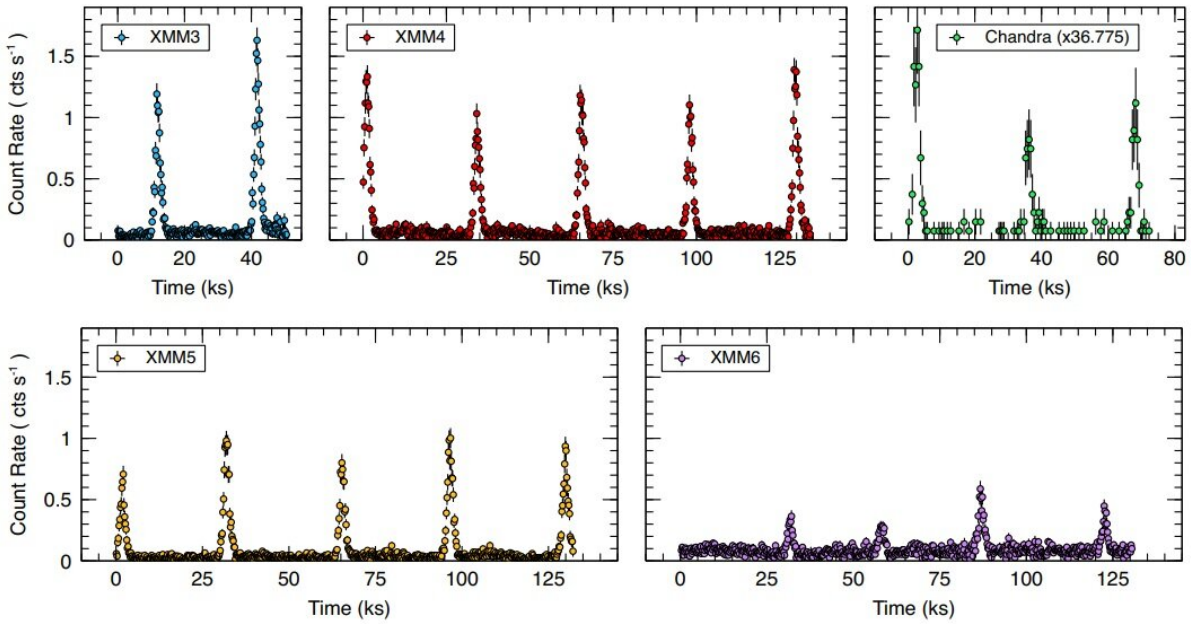

XMM-Newton (EPIC-pn) and Chandra (ACIS-S) background-subtracted light curves from all observations with QPEs of GSN 069 in a common 0.4-1 keV band. Credit: Miniutti et al., 2022.

Using ESA's XMM-Newton satellite and NASA's Chandra spacecraft, an international team of astronomers has investigated a peculiar behavior of quasi-periodic eruptions (QPEs) in an active galaxy known as GSN 069.

Results of the study, published July 15 on arXiv.org, shed more light on the nature of the QPE phenomenon.

X-ray quasi-periodic eruptions are a recently discovered phenomenon associated with supermassive black holes at the centers of galaxies. They are extreme high-amplitude bursts of X-ray radiation recurring every few hours and originating near the central supermassive black holes (SMBHs) in galactic nuclei.

Located some 250 million light years away in the constellation of Sculptor, GSN 069 is an active galaxy first detected in 2010 with XMM-Newton. The central black hole of this galaxy has a mass of about 400,000 solar masses.

XMM-Newton observations of GSN 069, conducted in December 2018, revealed that -ts X-ray light curve showcases high-amplitude, short-lived X-ray flares recurring every nine hours. These QPEs were found to be producing an increase of the X-ray count rate by up to two orders of magnitude in the hardest energy bands.

Now, in order to get more insights into the nature of the bursts of GSN 069, a group of astronomers led by Giovanni Miniutti of Spanish Astrobiology Center in Madrid, Spain, analyzed data from XMM-Newton and Chandra collected between 2010 and 2021.

"In this work, we present results obtained from 12 pointed X-ray observations of GSN 069 (11 by XMM-Newton and 1 by Chandra) and we discuss the short- and long-timescale properties of both QPEs and continuum (quiescent) emission over the past 11 years," the researchers wrote.

The study confirmed that QPEs in GSN 069 are a transient phenomenon. First QPE in this galaxy was identified on December 24, 2018 and the

last one in January 2020. These eruptions had an overall time between 1 and 5.5 years.

It turned out that QPEs measured in high energy bands are stronger, peak earlier and have shorter duration than when measured at softer energies. It was found that the quiescent level variability in observations with QPEs exhibits a quasi-periodic oscillation (QPO) at the average observation-dependent recurrence time.

The research also found that, starting from the last observation during which QPEs are detected, the X-ray emission of GSN 069 re-brightened significantly, reaching a second peak about 10–11 years after the first X-ray detection.

The astronomers concluded that the QPE properties of GSN 069, together with the long-term X-ray evolution, may be explained by a scenario in which a binary consisting of two white dwarfs (WDs) is captured by the SMBH whose tidal forces eject one component, while the other forms a binary on a highly eccentric orbit with the SMBH.

"The surviving WD is still on a highly eccentric orbit that is shrinking due to energy and angular momentum losses and, after a few years from the initial TDE-like [tidal disruption event-like] event, overfills its own Roche lobe at each pericenter passage. The consequent tidal stripping events produce the observed QPEs (one per each episode of mass transfer at pericenter)," the researchers explained.

More information: G. Miniutti et al, Disappearance of quasi periodic-eruptions (QPEs) in GSN 069, simultaneous X-ray re-brightening, and predicted QPE re-appearance. arXiv:2207.07511v1 [astro-ph.HE], arxiv.org/abs/2207.07511