Quasi-periodic oscillation detected in the galaxy NGC 4945

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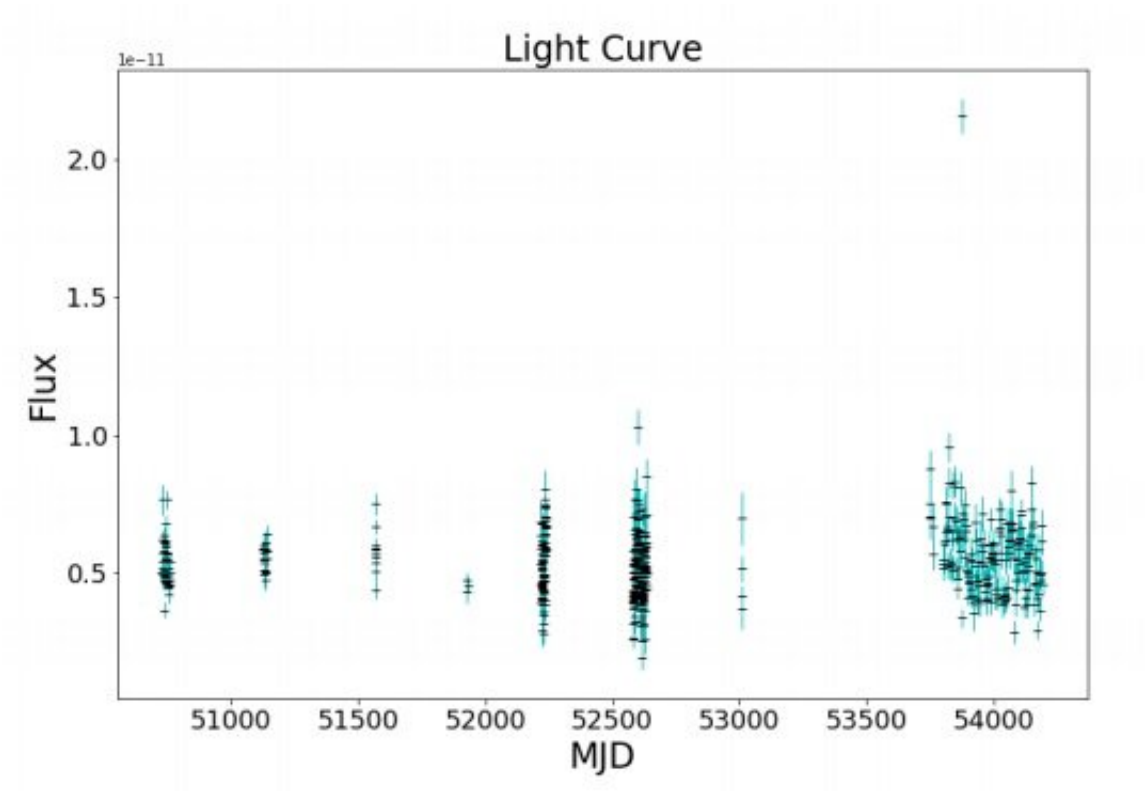

The NGC 4945 light curve of RXTE observations between 1997 and 2007. Credit: Smith et al., 2020.

Using data from the Rossi X-ray Timing Explorer (RXTE) satellite, astronomers from the Florida Institute of Technology have discovered a quasi-periodic oscillation (QPO) in the galaxy NGC 4945. The finding, reported in a paper published September 28 on the arXiv preprint server,

could shed more light on the nature of this galaxy.

When X-ray light from an astronomical object flickers about certain frequencies, the phenomenon is known as a QPO. It is believed that they occur when X-rays are emitted near the inner edge of an accretion disk in which gas swirls onto a compact object, for instance, a neutron star or a black hole. Given that supermassive black holes in some galaxies also have accretion disks, QPOs can be detected in those galaxies, too.

Located some 11.7 million light years away from the Earth, NGC 4945 is a barred spiral galaxy in the constellation Centaurus with an estimated mass of about 1.4 million solar masses. Observations suggest that NGC 4945 is an active galaxy (type 2 Seyfert) that may contain a supermassive black hole.

Recently, a team of astronomers led by Evan Smith has conducted a search for low-frequency (LF) QPOs, combing through archival data from RXTE, obtained between 1996 and 2011. The satellite completed more than 500 observations of NGC 4945's active galactic nucleus (AGN) and found that it exhibits an LFQPO.

"Between MJD 54003-54193 (RXTE proposal 60139) (Madejski 2001), the Lomb-Scargle periodogram shows a candidate QPO at 0.274 μHz or a period of 42.2 ± 3 days," the astronomers wrote in the paper.

As noted by in the study, the light curve from RXTE observations in the 2–10 keV band shows a prominent LFQPO with a period of approximately six weeks. The newly detected oscillations are also seen near this period in other three sub-bands.

The astronomers noted that possible explanations for the observed QPO in NGC 4945, as well as in other active galaxies, include Keplerian orbital motion of matter in the disk, spin of the central compact object,

general relativistic effects, or beat frequencies between two of the previous mechanisms. They added that the available data does not allow to choose the most plausible hypothesis.

According to the paper, NGC 4945 is one of the brightest Seyfert galaxies at 100 keV, has a total bolometric luminosity of about 20 tredecillion erg/s and is radiating at around 10 percent of the Eddington luminosity. Images of NGC 4945 from NASA's Chandra spacecraft show that this galaxy has a resolved, flattened, clumpy structure about 490 light years long, with a spectrum consistent with cold reflection of the AGN emission.

Summing up the results, the researchers draw some conclusions regarding the stability of the QPO phenomenon in NGC 4945. They assume that the quasi-periodic oscillation in this galaxy may only be stable for a 190-day period.

More information: A QPO in NGC 4945 from Archival RXTE Data, arXiv:2009.13393 [astro-ph.HE] arxiv.org/abs/2009.13393

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