AstroSat observations unveil properties of black hole binary MAXI J1820+070

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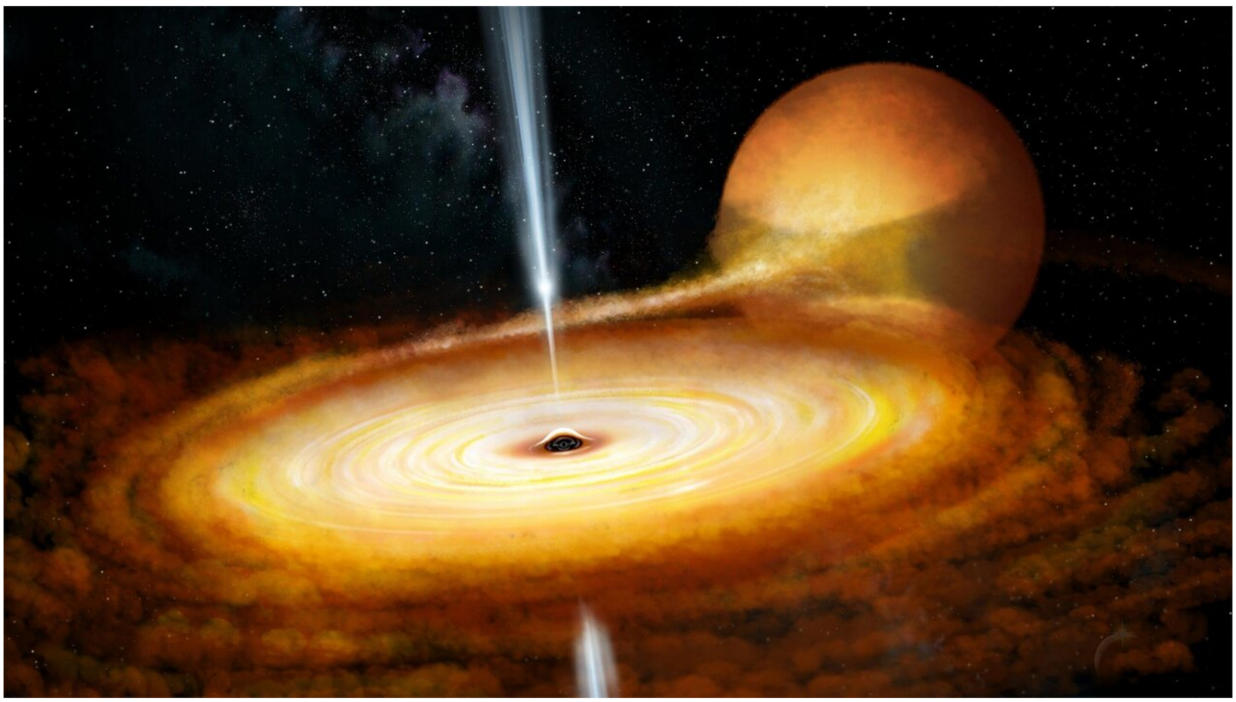

Illustration of MAXI J1820+070. Credit: John Paice.

Simultaneous spectral and temporal observations of the newly detected black hole X-ray binary (BHXB) MAXI J1820+070 using the AstroSat spacecraft, have delivered more insights into the properties of this source. Results of the study, presented in a paper published January 6 on arXiv.org, could be helpful in improving our understanding of black hole binaries in general.

X-ray binaries consist of a normal star or a white dwarf transferring mass onto a compact neutron star or a black hole (BHXB). During outbursts, BHXBs showcase random short-term variability in their flux, and such behavior is a subject of numerous studies aiming to disentangle their origin.

Observations have shown that the X-ray variability in BHXBs is well represented by their power density spectra (PDS). In most cases, these spectra are characterized by broadband continuum noise-like features, however, they sometimes exhibit narrow peak features called quasi-periodic oscillations (QPOs). The exact mechanism of such oscillations is still not fully understood and requires further studies.

Located some 11,300 light years away, MAXI J1820+070 is a BHXB first detected in March 2018 as a black hole X-ray transient. Its outburst cycle was found to last for almost a year, showcasing rapid, frequent, alternating transitions between hard and soft spectral states. Indian astronomers, led by Sneha Prakash Mudambi of Christ University in Bangalore, India, decided to take a closer look at this binary, hoping to get more detailed information about its properties.

"We report the results of spectro-timing analysis of MAXI J1820+070 as observed by SXT and LAXPC onboard AstroSat for the first time. We have analyzed ~ 93 ks of observed data corresponding to 15 individual satellite orbits," the astronomers wrote in the paper.

According to the study, the spectrum of MAXI J1820+070 was found to be dominated by a thermal Comptonization component along with disk emission and a reflection component. Spectral index was measured to be approximately 1.61, which suggests that the source was in the hard spectral state with a cool disk (disk temperature of about 0.22 keV) truncated at a large distance (around 526 kilometers).

Furthermore, the study detected a quasi-periodic oscillation with the centroid frequency at 47.7 mHz. The astronomers noted that the PDS of MAXI J1820+070, besides this QPO, could be modeled with four other components: a weak oscillation at 109.4 mHz and three broadened noise humps spread over 0.004 to 30 Hz.

"The spectrum shows a prominent QPO at 47.7 mHz and three broadened noise humps, which can be represented by Lorentzians. There is also a weak feature at 109.4 mHz," the paper reads.

Summing up the results, the researchers emphasized AstroSat's importance for spectral and temporal studies of X-ray binaries and other sources. They added that the satellite has the capability of measuring the broadband time-averaged spectrum and the energy-dependent temporal behavior of such systems as MAXI J1820+070, which allows researchers to quantitatively fit both spectral and temporal data.

More information: Unveiling the temporal properties of MAXI J1820+070 through AstroSat observations, arXiv:2001.00755 [astro-ph.HE] arxiv.org/abs/2001.00755

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