Astronomers observe the awakening of a Be/X-ray binary

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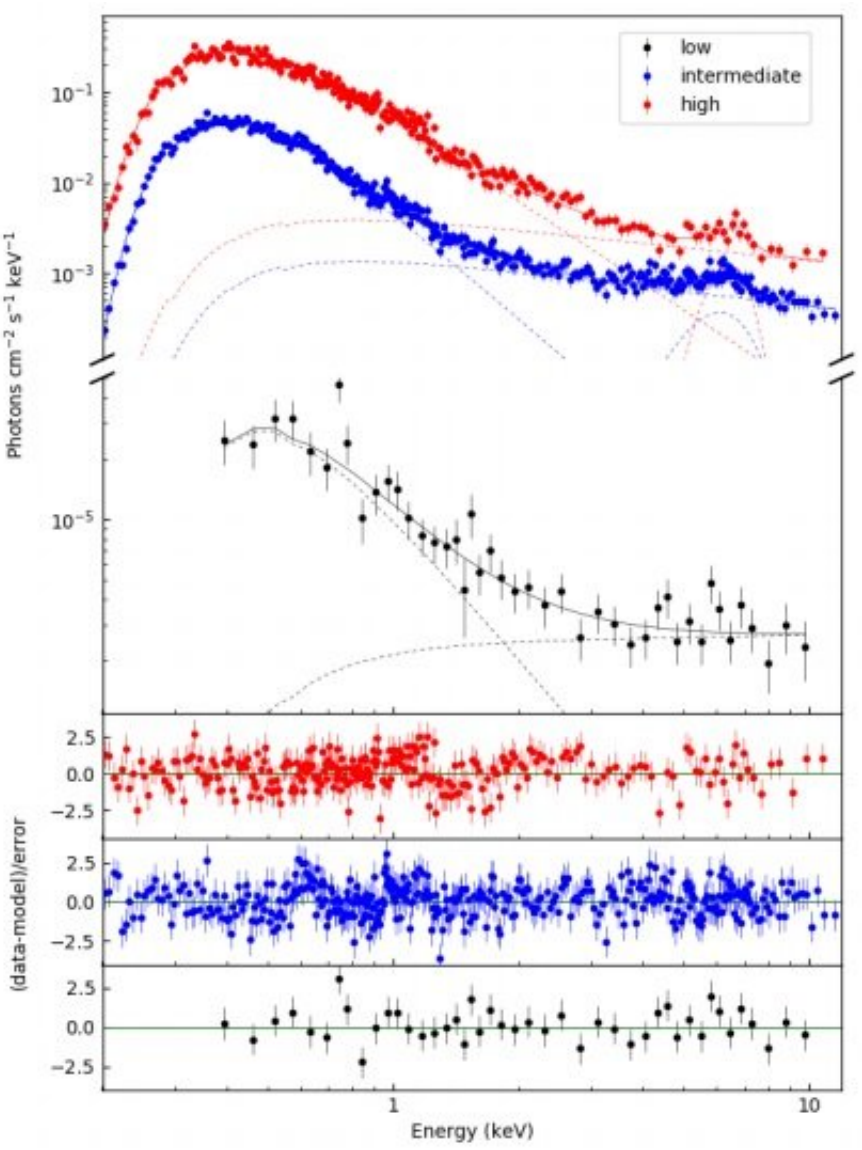

XMM-Newton spectra of A0538−66 during the three luminosity levels, fitted with two absorbed power laws (plus a Gaussian line for the intermediate and

high luminosity levels). The lower panels show the residuals of the fits. Image credit: Ducci et al., 2019.

Using ESA's XMM-Newton space telescope, astronomers have spotted bright X-ray outbursts emitted by a Be/X-ray binary known as A0538−66. The discovery marks the ending of an over three-decade-long period of quiescence of this system. The finding is detailed in a paper published July 18 on arXiv.org.

Be/X-ray binaries (Be/XRBs) consist of Be stars and, usually, neutron stars, including pulsars. Observations have found that most of these systems showcase weak persistent X-ray emission that is interrupted by outbursts lasting several weeks.

Discovered in 1977, A0538−66 is a Be/XRB system located in the Large Magellanic Cloud (LMC). Many of the binary's properties make it remarkable. For instance, it hosts one of the fastest spinning pulsars know to date—with a period of only 69 milliseconds. It has also one of the shortest orbital periods (about 16.64 days) and one of the highest eccentricities (approximately 0.72) among the Be/XRBs so far identified.

During the first years after its discovery, A0538−66 was observed to emit bright X-ray outbursts with peak luminosity reaching even duodecillion erg/s. Afterward, the source entered a quiescent period during which its luminosity varied from 5.0 decillion to 40 undecillion erg/s.

Now, a team of astronomers led by Lorenzo Ducci of Eberhard Karls University of Tübingen, Germany, reports that A0538−66 is once again active. Observations of this binary conducted last year with the use of

XMM-Newton, show that it is emitting bright X-ray outbursts.

"In 2018, we carried out XMM-Newton observations of A0538−66 during three consecutive orbits when the pulsar was close to periastron. In the first two observations, we discovered a remarkable variability, with flares of typical durations between two to 50 seconds and peak luminosities up to 400 undecillion erg/s (0.2−10 keV)," the astronomers wrote in the paper.

According to the paper, the flares were absent when the source was observed for the third time in 2018, and its luminosity was measured to be about 20 decillion erg/s. Between the two outbursts, the luminosity was found to be about 10 times higher.

The astronomers emphasized how powerful and fast the two observed outbursts were. They noted that such fast flaring activity has never been observed in A0538−66, or most probably any other known Be/XRB.

Pondering the possible explanation for such peculiar flaring activity, the researchers point to transitions between the accretion and supersonic propeller regimes. However, although they find this scenario the most plausible, they do not exclude any other hypotheses at the moment.

"Although other explanations for the observed variability cannot be excluded, we speculate that the strong and rapid flares occur because the source was accreting from a spherically symmetric flow, not mediated by an accretion disk. In these conditions, an atmosphere can form above the NS [neutron star] magnetosphere, and flares might be produced by rapid changes between the accretion and supersonic propeller regime," the authors of the paper concluded.

They added that more studies of spectral properties of A0538−66, focused at higher energies, could help verify the possible scenarios.

More information: Awakening of the fast-spinning accreting Be/X-ray pulsar A0538-66, arXiv:1907.08078. arxiv.org/abs/1907.08078