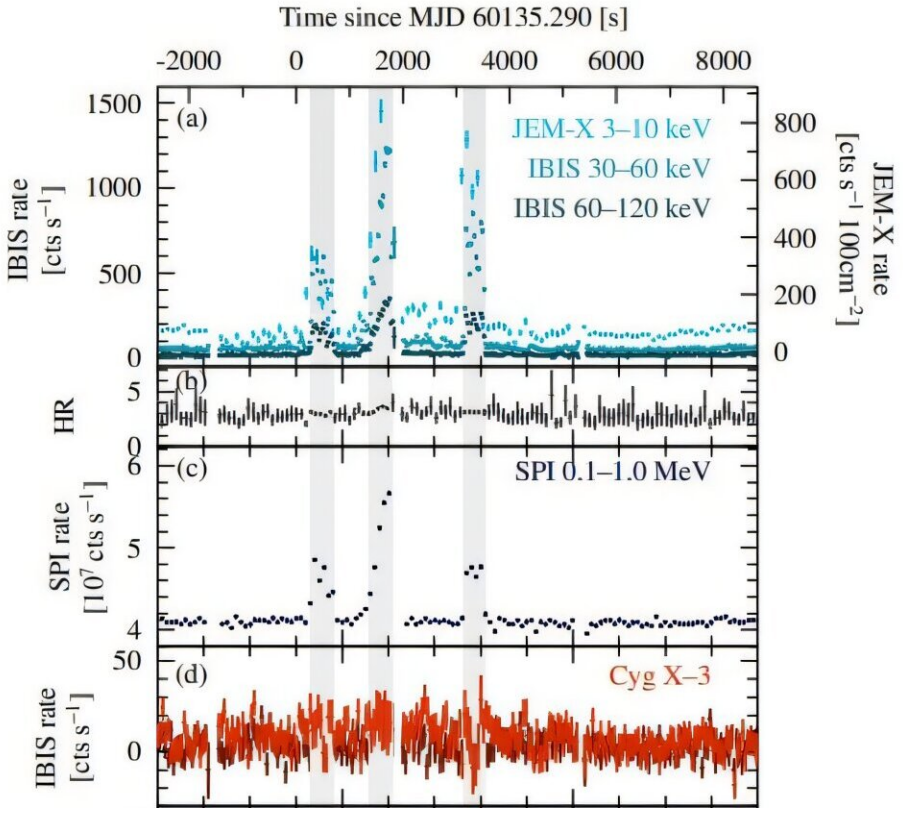
INTEGRAL observes exceptionally bright X-ray flares from Cygnus X-1

September 8 2025, by Tomasz Nowakowski



Variability of Cygnus X-1 on July 10, 2023. Credit: *arXiv* (2025). DOI: 10.48550/arxiv.2508.20874

Using ESA's INTEGRAL spacecraft, astronomers have detected exceptionally bright X-ray flares from the Cygnus X-1 X-ray binary

system. This is the first time that such strong flaring activity has been observed in this system although it has been monitored for decades. The new findings were detailed in a paper published August 28 on the pre-print server *arXiv*.

Located some 6,100 light years away from Earth in the constellation Cygnus, Cygnus X-1 is a bright, persistent high-mass X-ray binary (HMXB) consisting of a black hole accreting matter from an OB star. Previous observations of this source have shown that its X-ray emission undergoes dramatic changes in spectral distribution and brightness.

Given that Cygnus X-1 was discovered in 1962, it has been extensively monitored in X-rays, which resulted in the detection of flaring activity on this source.

Now, a team of astronomers led by Philipp Thalhammer of the Dr. Karl Remeis Observatory in Bamberg, Germany, reports the discovery of three unprecedentedly bright X-ray flares on Cygnus X-1, which have not been reported yet for this system.

"The three flares represent extreme source behavior that has not been seen previously in the 21 years of monitoring of Cygnus X-1 with INTEGRAL, nor in the earlier RXTE [Rossi X-ray Timing Explorer] monitoring between 1997 and 2012," the researchers explain.

The three flares occurred during the soft-intermediate spectral state of Cygnus X-1, when the source was moving toward the hard state. The flares lasted about 400 seconds each, and reached a 1–100 keV peak luminosity at a level of 110–260 undecillion erg/s.

According to the paper, the intensity profiles of the flares are complex with fast rise and decay times for the first and third flare, and a slow rise and fast decay for the second flare. It was also found that in the case of

all the three flares, the normalized root-mean-square (rms) variability is significantly increased.

The astronomers note that the only comparable event in Cygnus X-1 to the newly identified flares was detected by RXTE in April 2005. It had a similar duration and coincided with a radio flare that was delayed by about 400 seconds with respect to the X-ray flare.

Trying to explain the origin of such bright X-ray flaring activity in Cygnus X-1, the authors of the paper point to a sudden and brief release of energy. They assume that this could be due to the ejection of material in an unstable jet or due to the interaction of the jet with the ambient clumpy stellar wind.

The scientists conclude that the case of Cygnus X-1 underlines the need for re-investigation of well-known X-ray sources.

"The observations presented here illustrate the need for continued monitoring even of supposedly 'well-known' sources, since it allows us to catch dramatic and very rare events in such systems," the researchers write.

More information: P. Thalhammer et al, Unprecedentedly bright X-ray flaring in Cygnus X-1 observed by INTEGRAL, *arXiv* (2025). DOI: 10.48550/arxiv.2508.20874

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