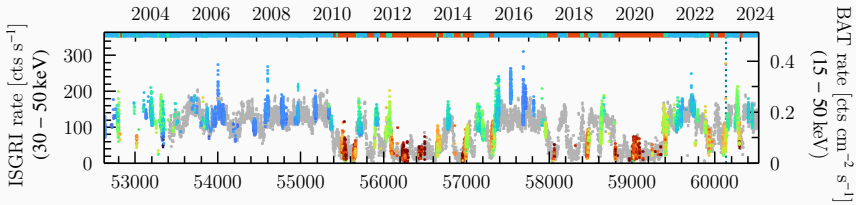
Unprecedented X-ray flaring in Cyg X-1 discovered after a lifetime of INTEGRAL monitoring

Philipp Thalhammer T. Bouchet J. Rodriguez F. Cangemi K. Pottschmidt D. Green C. Ferrigno M.A. Nowak V. Grinberg J. Wilms & others ...

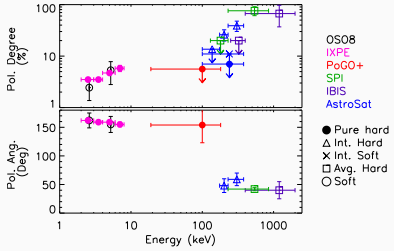
Dr. Karl Remeis-Observatory

ECAP / FAU

Cyg X-1: The briefest reminder



- 20 Ms of data by INTEGRAL (similar for RXTE)
- Extremely well studied!
- Usually < 300 cps in IBIS
- Recent polarization measurements (remember talks by e.g. Floriane & Tristan)



Chattopadhyay+2024

And then on a calm Monday morning in July 2023...

MMODA Multi-Messenger Online Data Analysis | UNIVERSITÉ DE GENÈVE FACULTÉ DES SCIENCES | ISDC EPFL | MMODA PRODUCT GALLERY

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Cyg X-1 isgri light curve

Coordinates

RA 299.59

Dec 35.20

Energy band

E1 (kev) 28.00

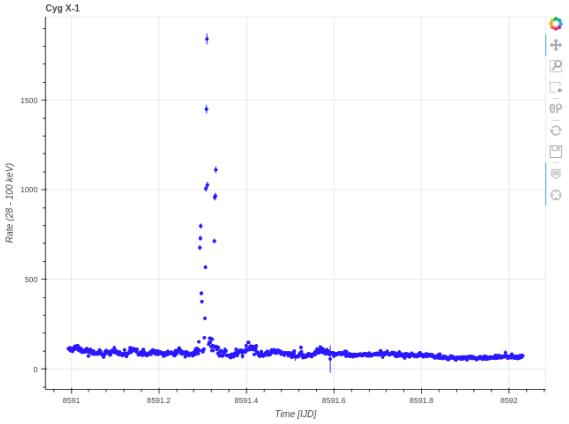
E2 (kev) 100.00

Time span

Tstart 2023-07-09T22:30:00 - revolution number: 2661

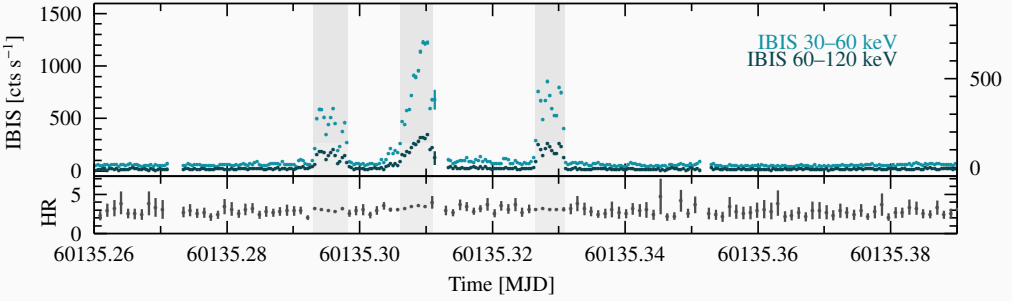
Tstop 2023-07-11T00:45:00 - revolution number: 2661

Time bin 100.00 s



Notebook | **Product type** | **Instrument** | **Proposal IDs** | **Sources**

A closer look...



Thalhammer et al. (in prep., 2024)

- $L_{30-80\,\mathrm{keV}}$: $\sim 6.5 \times 10^{37}\,\mathrm{erg\,s^{-1}}$
- $F_{30-80\,\mathrm{keV}}$: $\sim$ 14 Crab
- Each flare $\sim$ 10 min long
- Little change in HR

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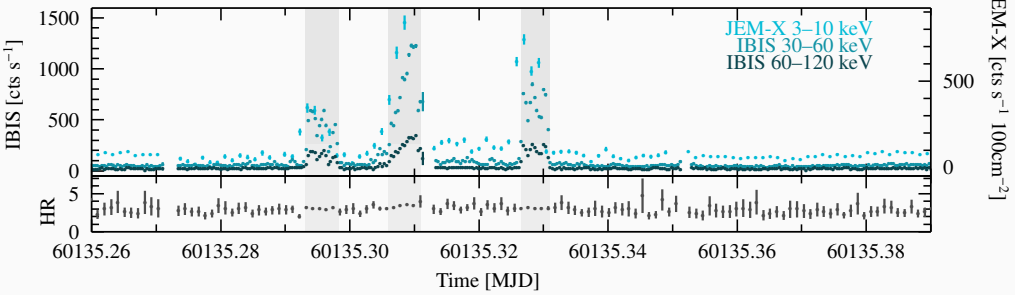

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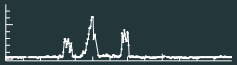
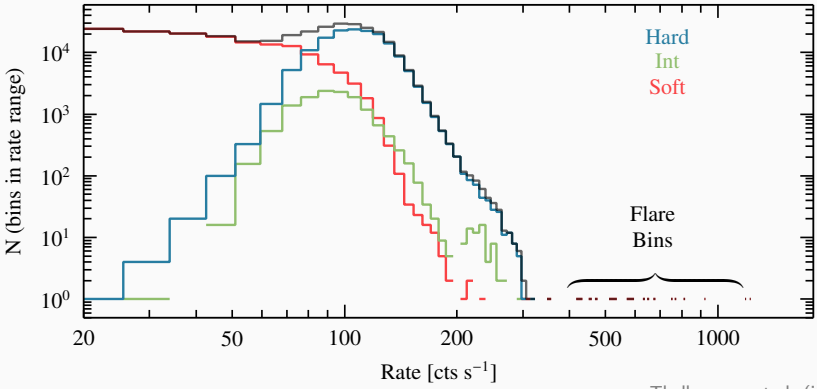
How unusual is this → quite!



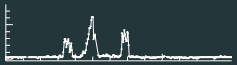


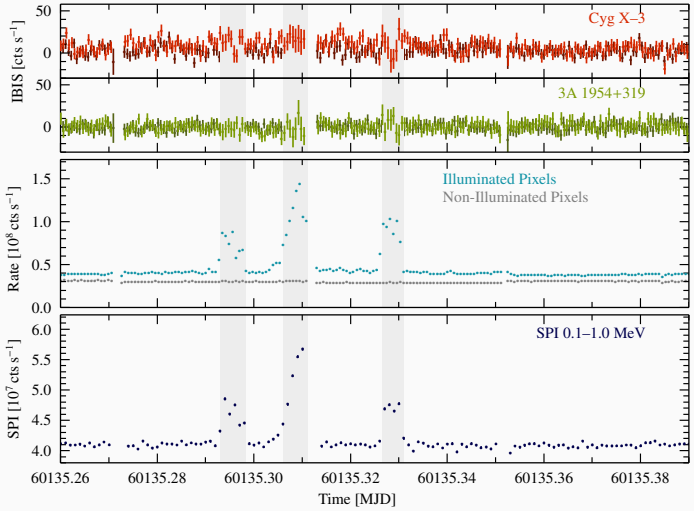
Thalhammer et al. (in prep., 2024)

- Histogram of 22 yrs of lightcurves
- Bin size dt : 60 s

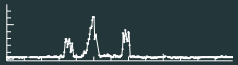
- $\sim$ 7 times brighter than any soft state
- $\sim$ 5 times brighter than anything so far

Background activity? → No



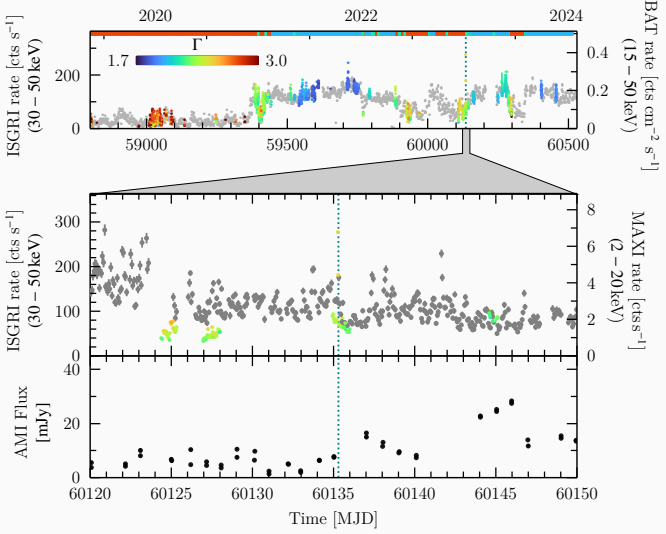


Other monitoring data:



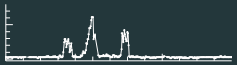
- Moved towards Hard State within weeks
- Falls withing radio gap (6h before to 40h after flares)
- MAXI: slight peak & dip afterwards

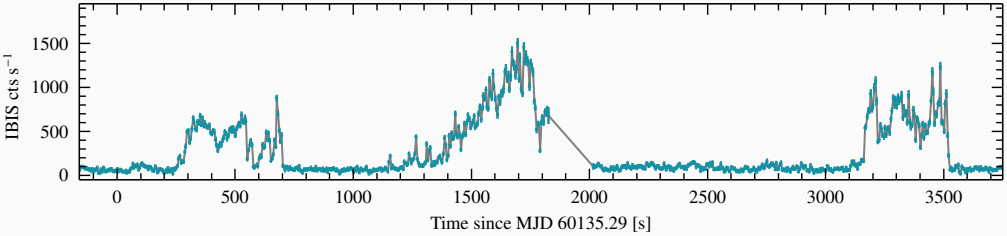
→ Have to rely on INTEGRAL



Thalhammer et al. (in prep., 2024)

Morphology of the flares:

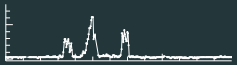


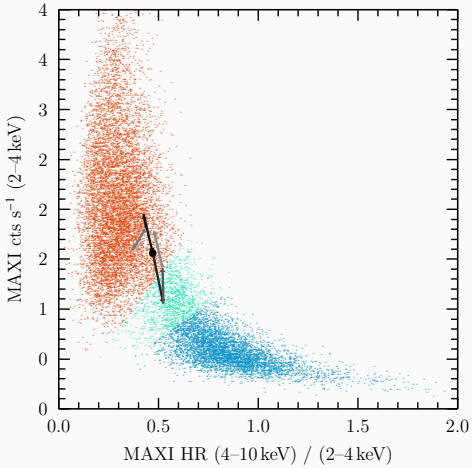


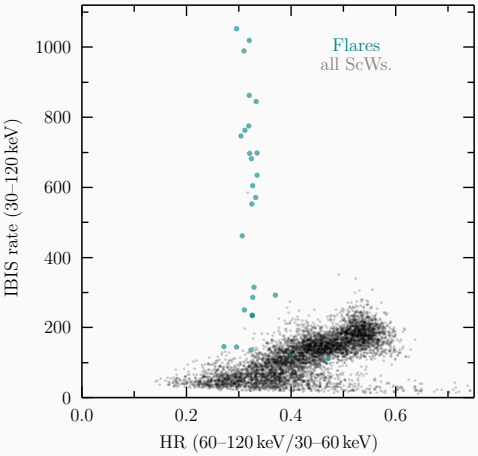
Thalhammer et al. (in prep., 2024)

- Peak Luminosity of >10 Crab in IBIS
- Rapid rise & decay within seconds
- Dynamic range of > 20
- Hardly any spectral change
- Total energy release of $\sim 2 \times 10^{41}\,\mathrm{erg}$
- Three flares then silence

What was Cyg X-1 doing at that time?

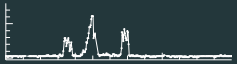


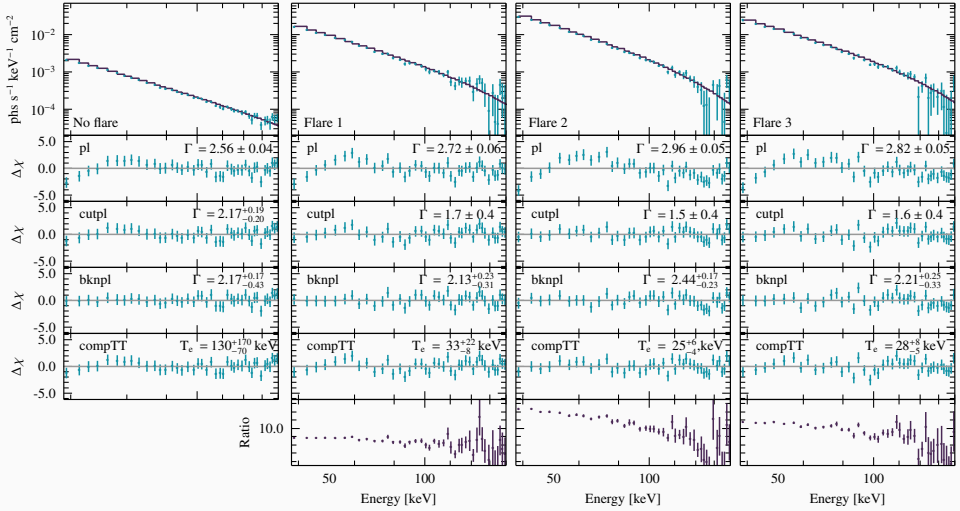




Thalhammer et al. (in prep., 2024)

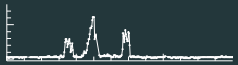
Spectral evolution:





Thalhammer et al. (in prep., 2024)

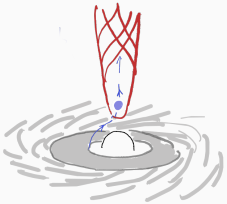
Physical explanation: Three scenarios



Bubble ejection

- Observed before
- Fits duration

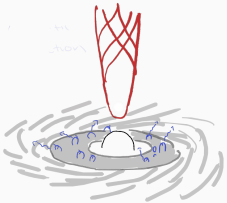
Wilms+2007, Beloborodov+1999



Magnetic reconnection

- Fits morphology
- Single event too short

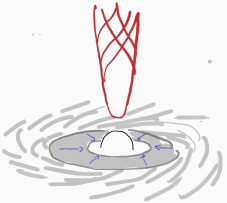
Ripperda+2022, El Mellah+2022



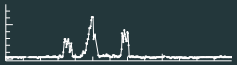
Change in disk radius

- No spectral change
- Can initiate ejection

Bhargava+22, Fender+2004



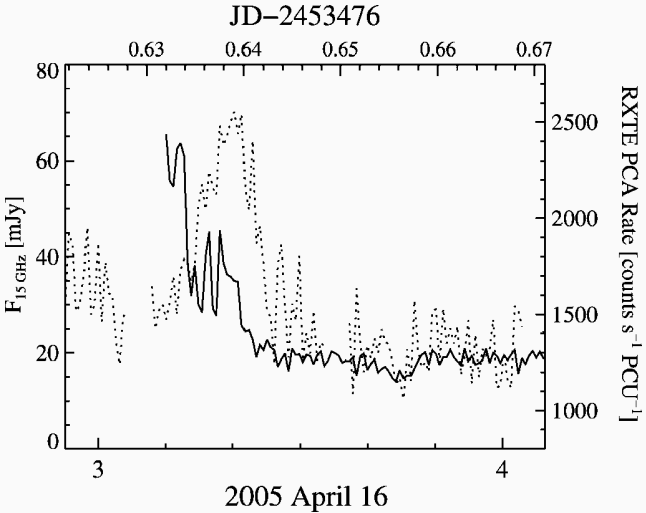
Closest historic precedence?



Wilms et al. 2007:

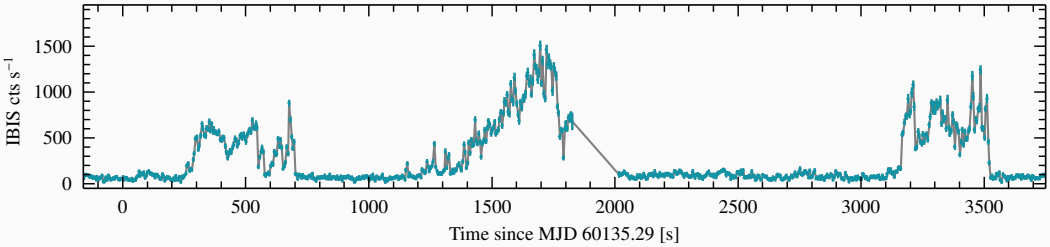
- Similar duration of $\sim$ 10 min
- Also during a SS transitioning to HS
- Lower dynamic range of $\sim$ 4
- Radio flare $\sim$ 7 min later

$\rightarrow$ Ejection along jet



Wilms+2007

Conclusion



Thalhammer et al. (in prep., 2024)

- New phenomenon for "old" source
- Importance of monitoring campaigns (radio & X-ray)
- This event is unprecedented in its luminosity
- Physics as of now unclear

$\rightarrow$ Paper forthcoming