# Observations of AT2019wey

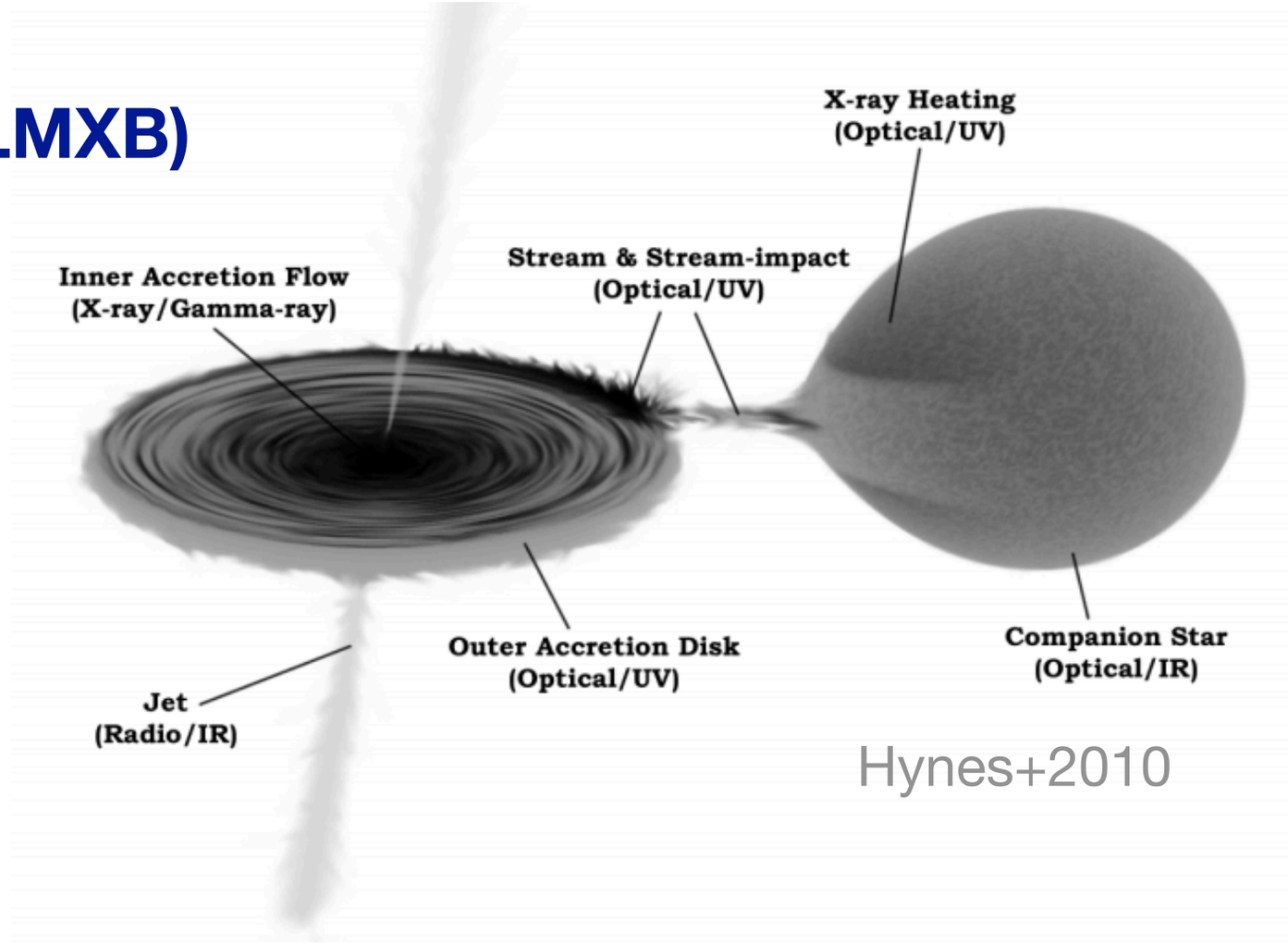
## The Mysterious Galactic Low-mass X-ray Binary

Yuhan Yao

Caltech
Oct 20, 2020

# Low-mass X-ray Binaries (LMXB)

- BH / NS accretor
- Low mass companion
- Accretion disk




Hynes+2010

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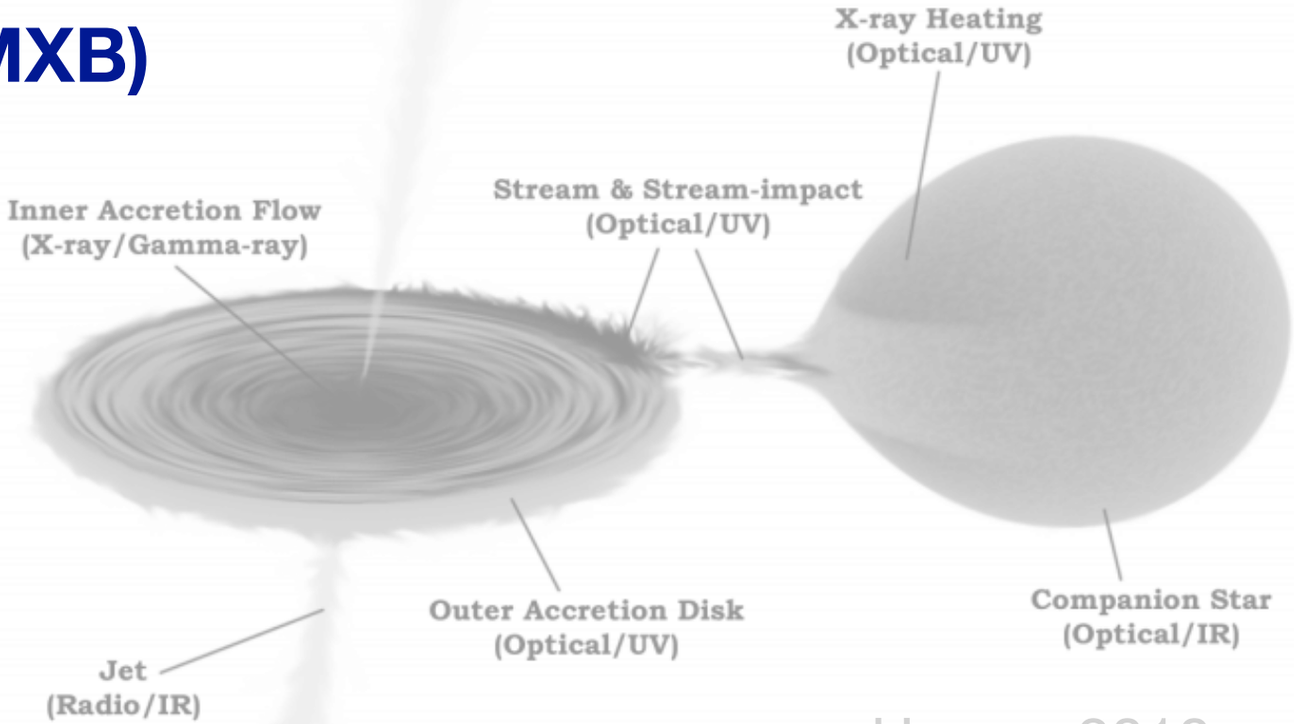
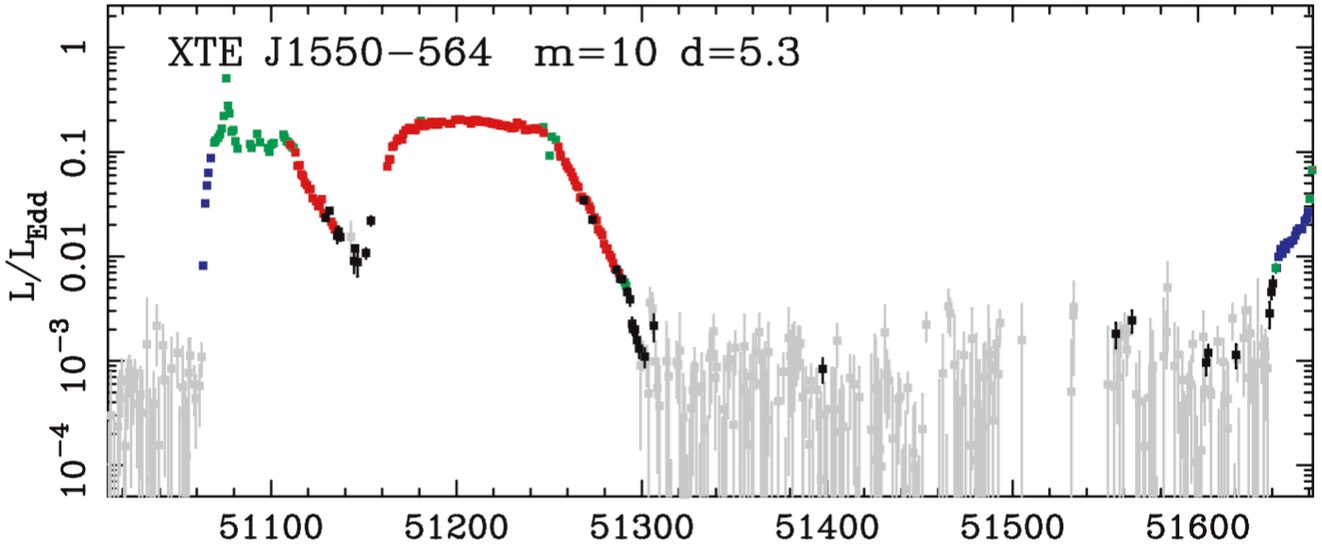
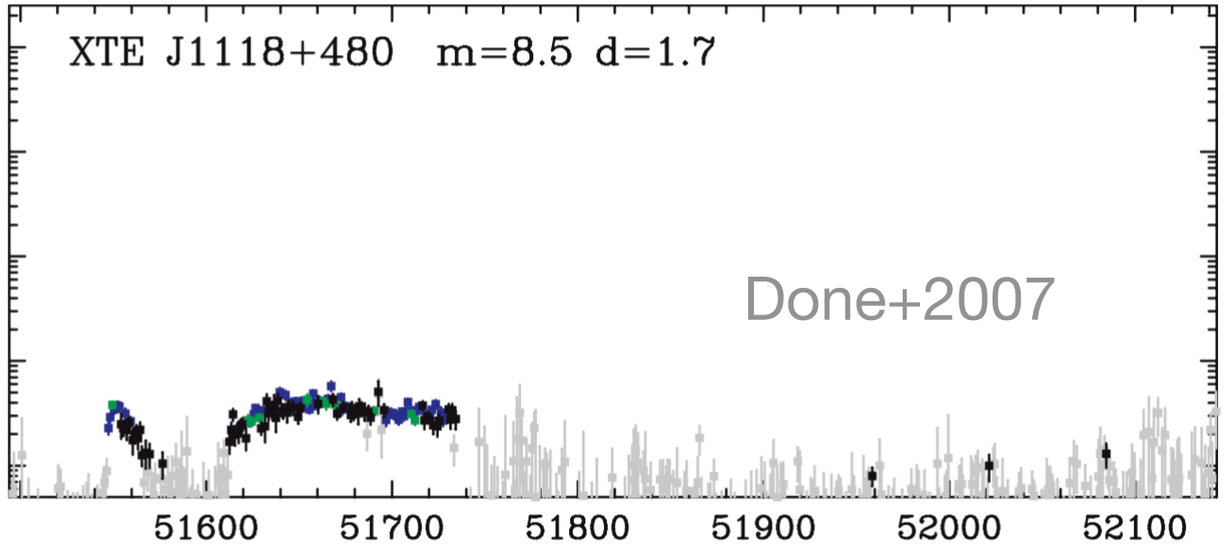



Hynes+2010

- All known LMXB BHB are transients




Done+2007

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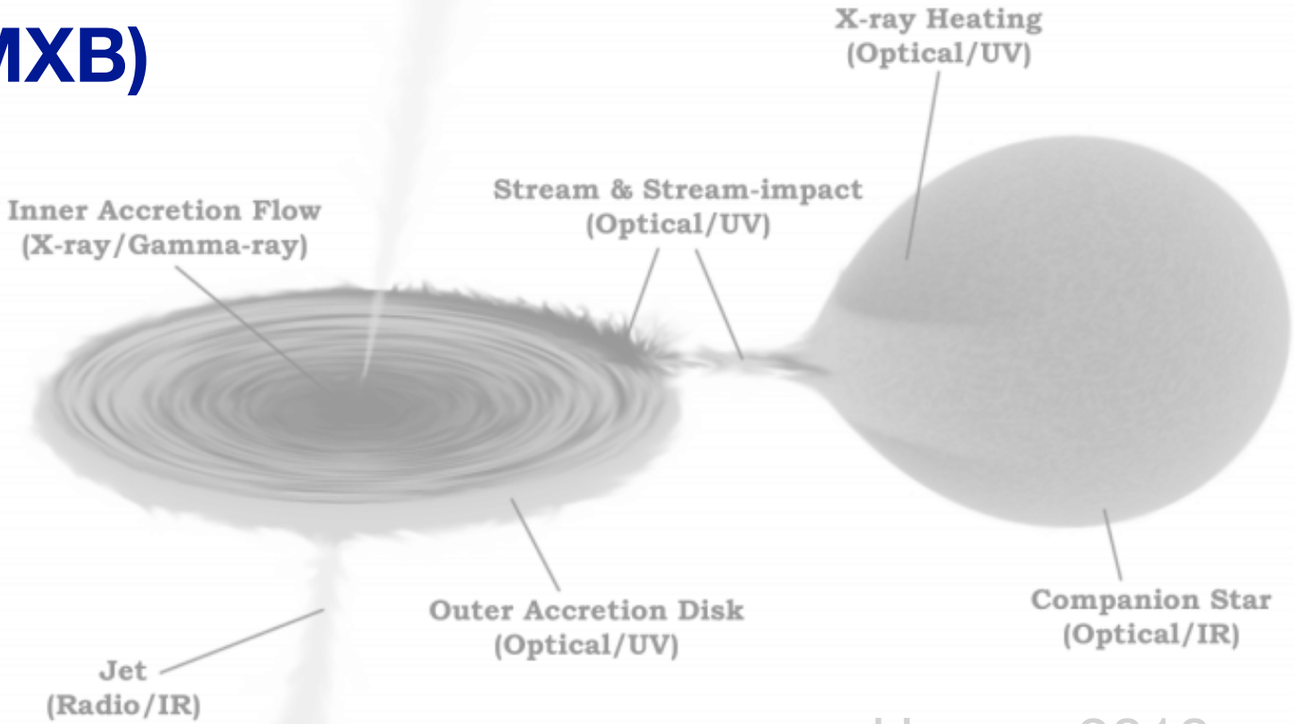


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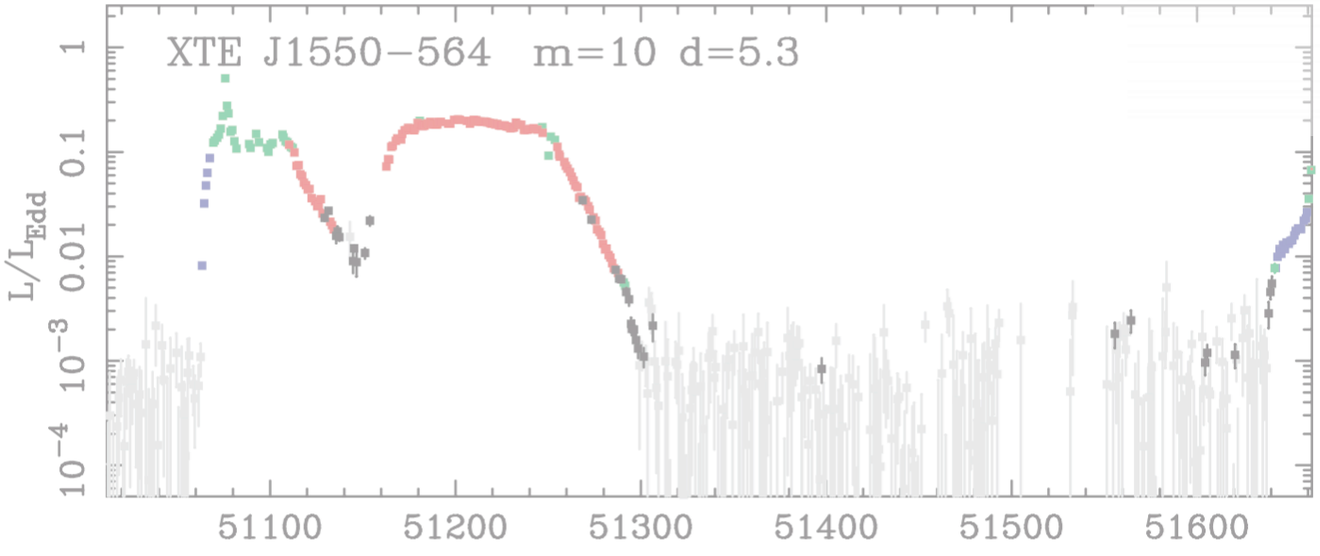
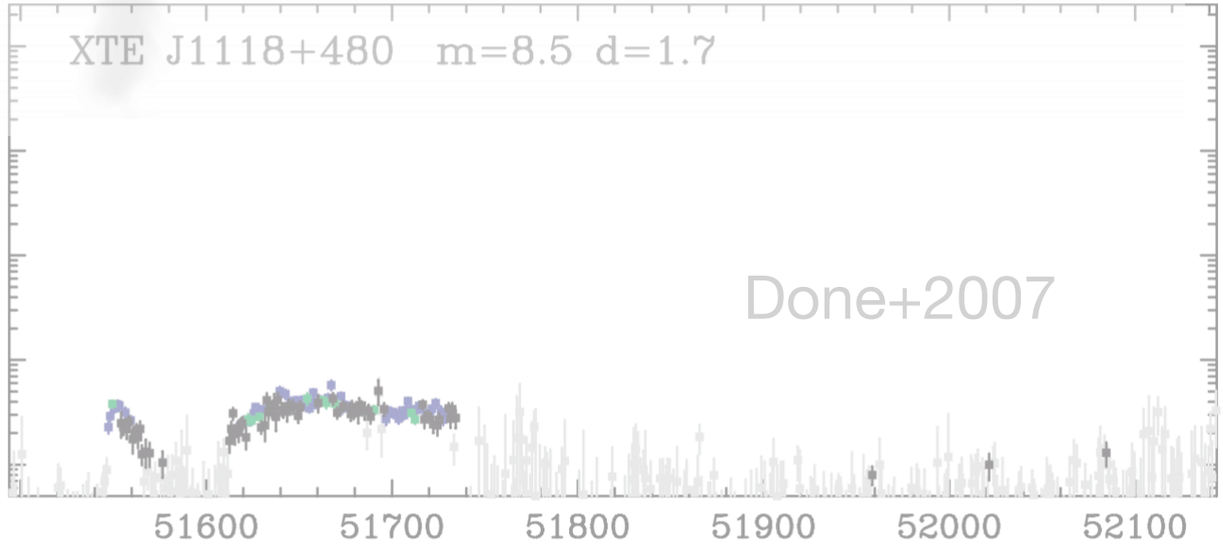


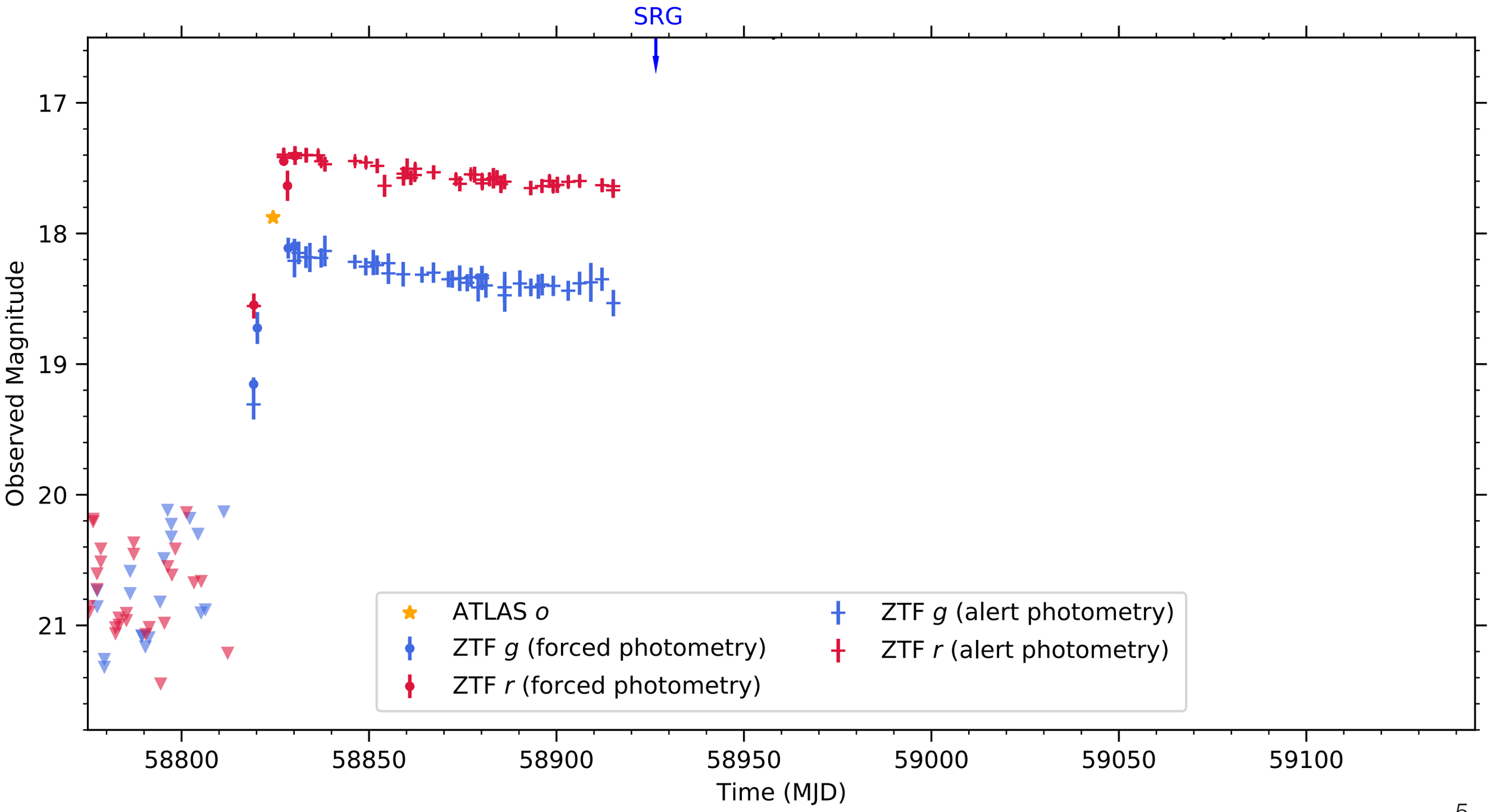

Done+2007

Find faint LMXB outbursts
- Using more sensitive X-ray surveys → ***SRG*** satellite
- Searching for outbursts in optical/IR → **ZTF, ATLAS, Gattini …**

# Discovery of an Optical and X-ray Transient

- ZTF 1st detection: Dec 2, 2019
- SRG discovery: Mar 18, 2020. ~1 mCrab.

**AT2019wey** / ZTF19acwrvzk

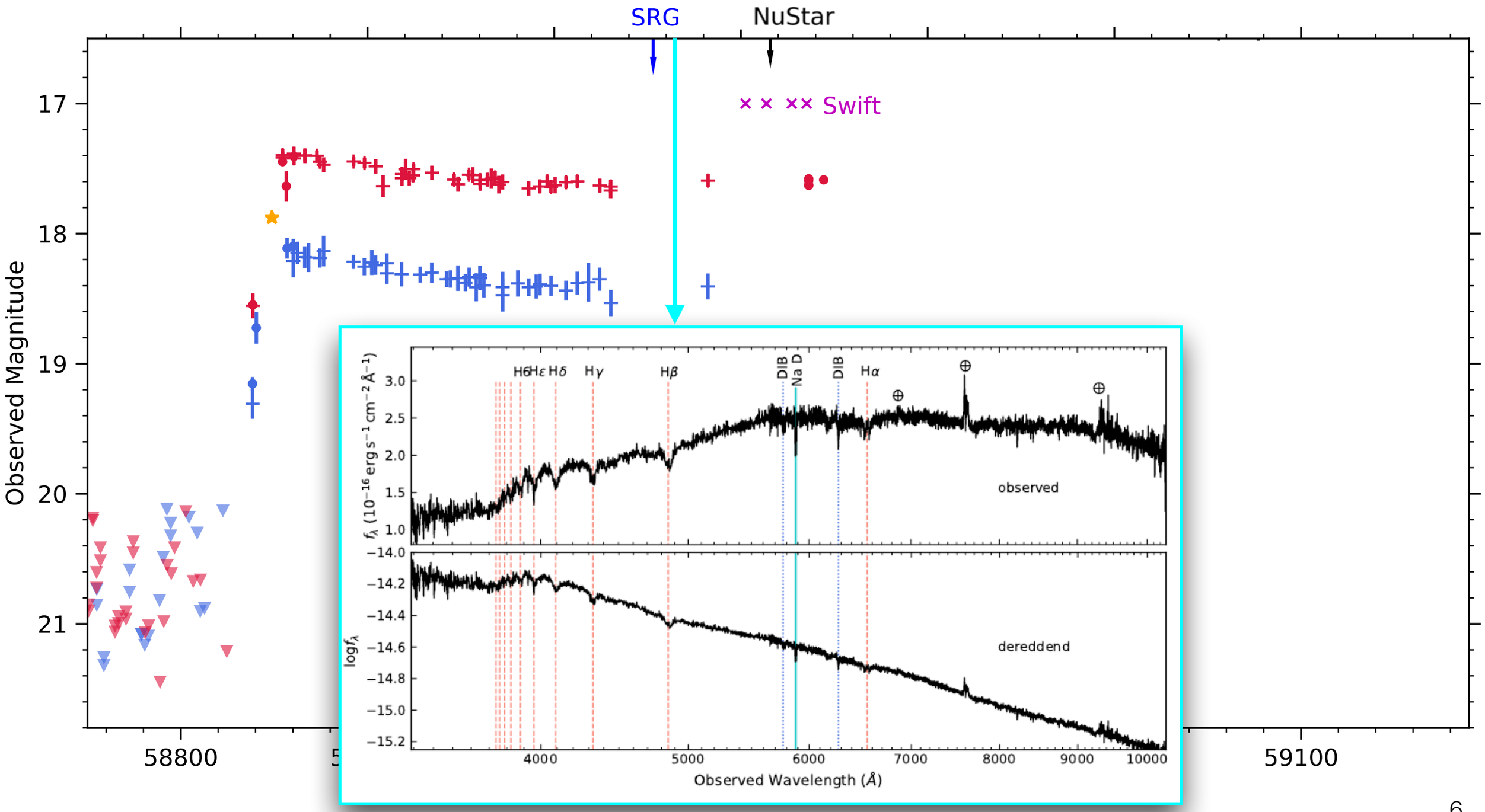


## Discovery of an Optical and X-ray Transient

## Galactic Origin
## *E(B-V)* ~0.8—1.3 mag

**AT2019wey** / ZTF19acwrvzk

- Blue continuum + broad Balmer lines
- *Swift*/*NuSTAR* spectrum in Apr: power-law Γ~1.8



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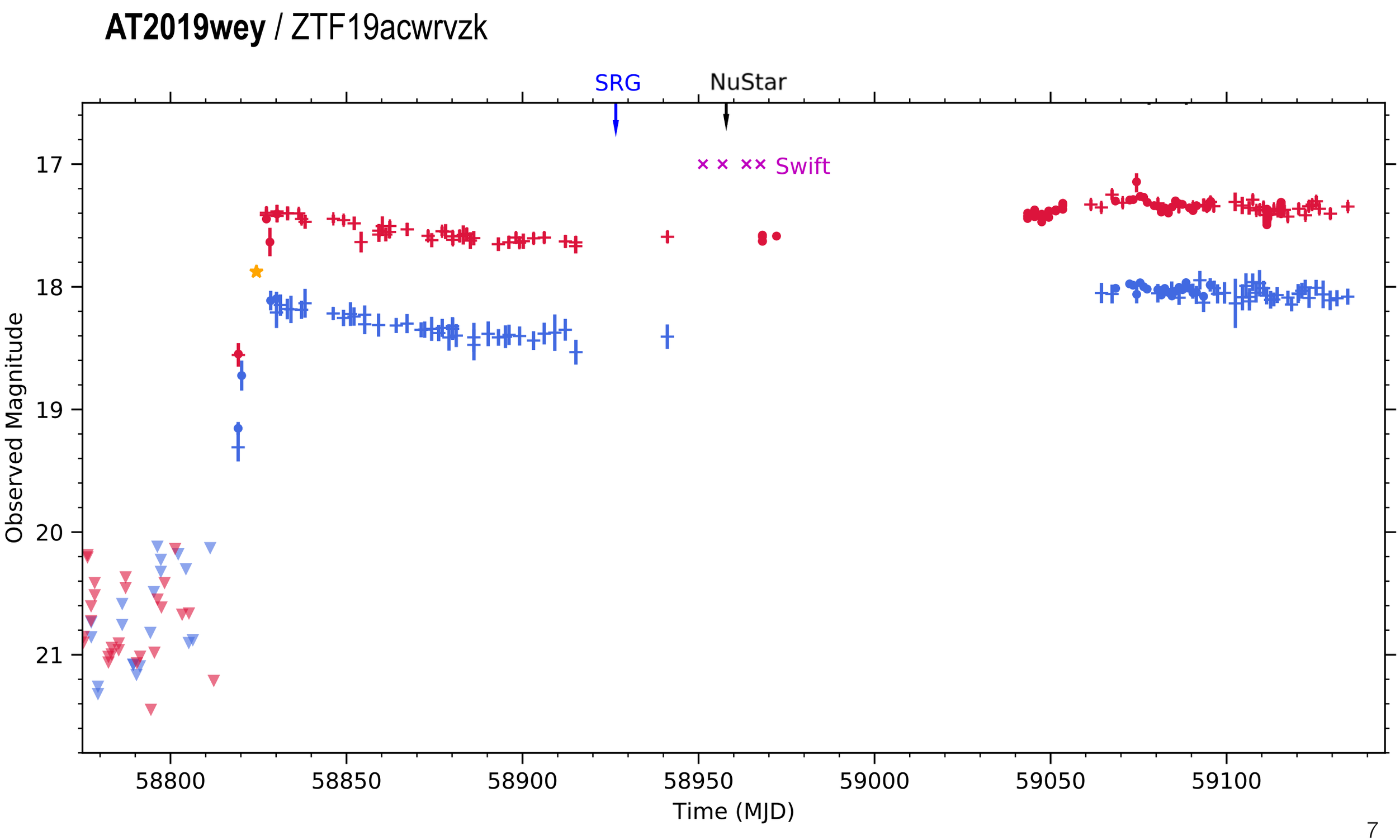

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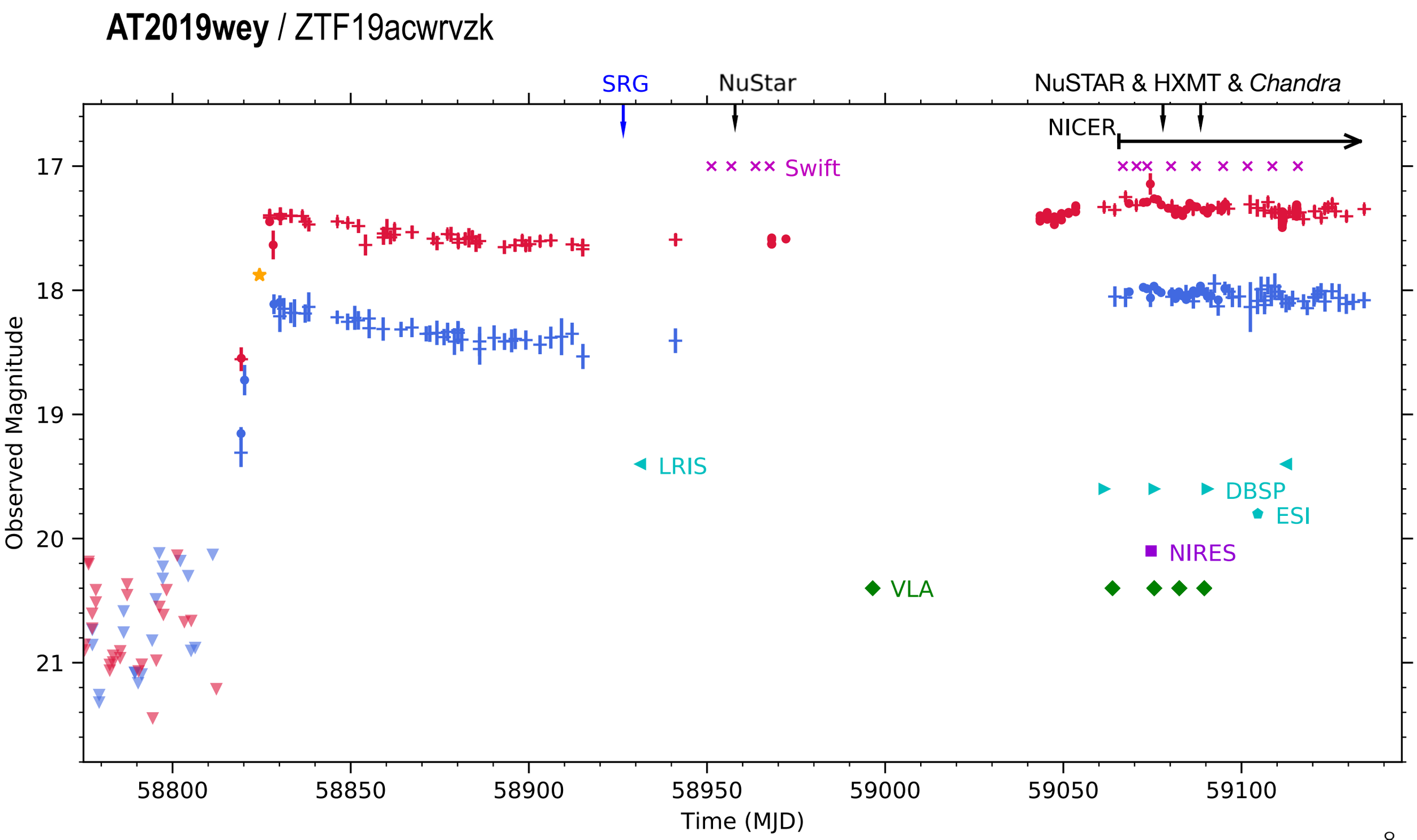
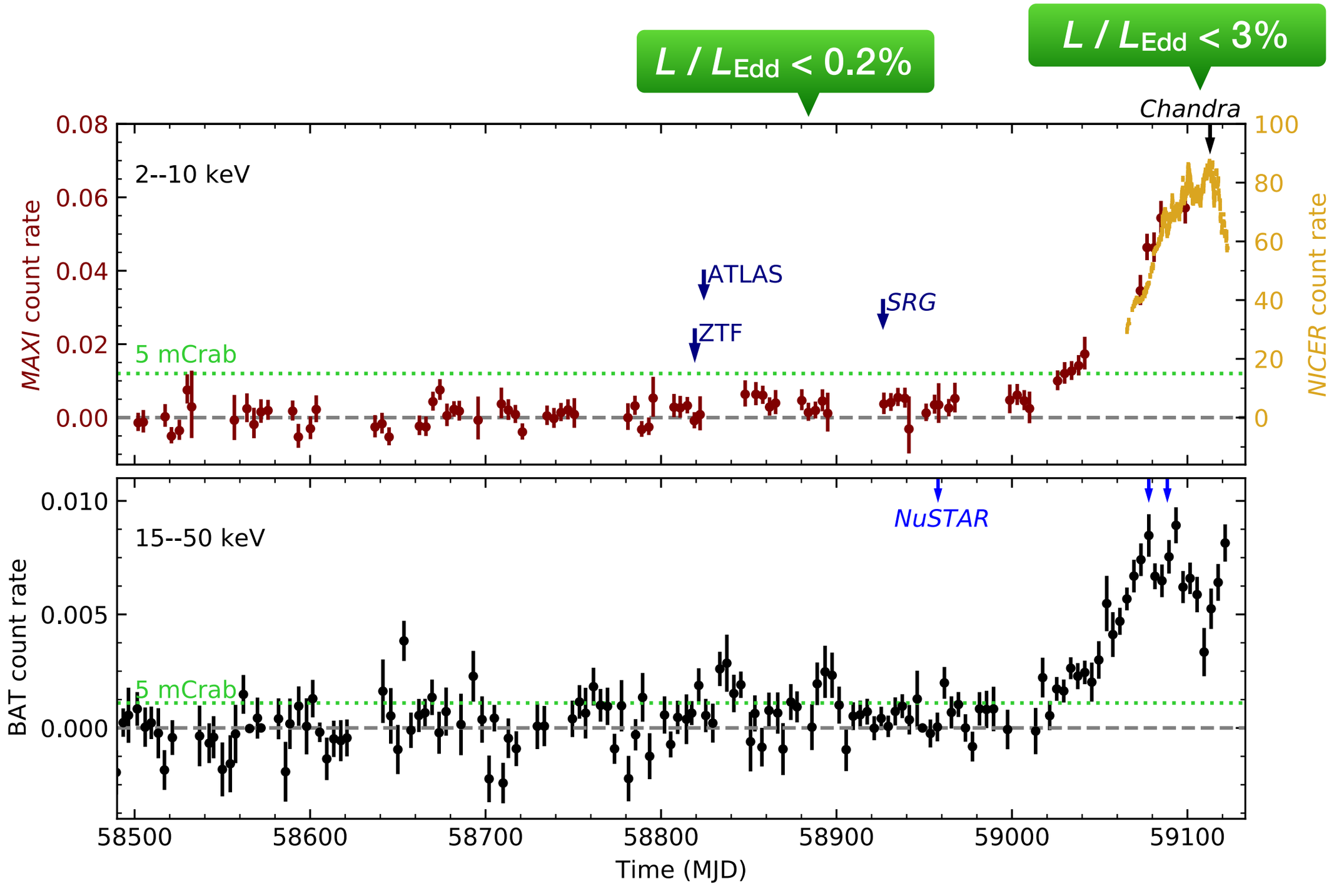
**Comprehensive Multi-wavelength Follow-up**



# X-ray Properties

- Brightened from 1mCrab to ~25mCrab



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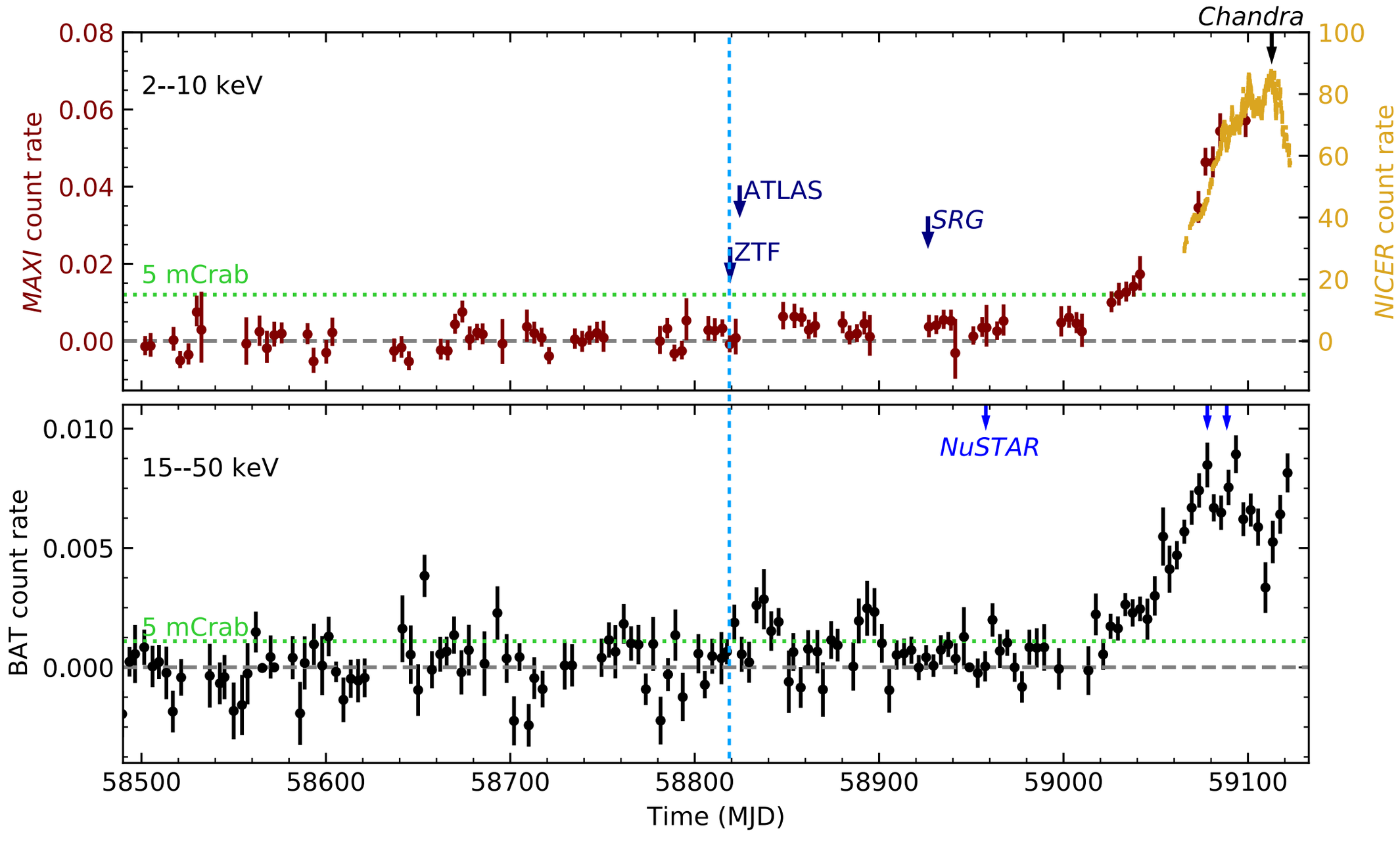

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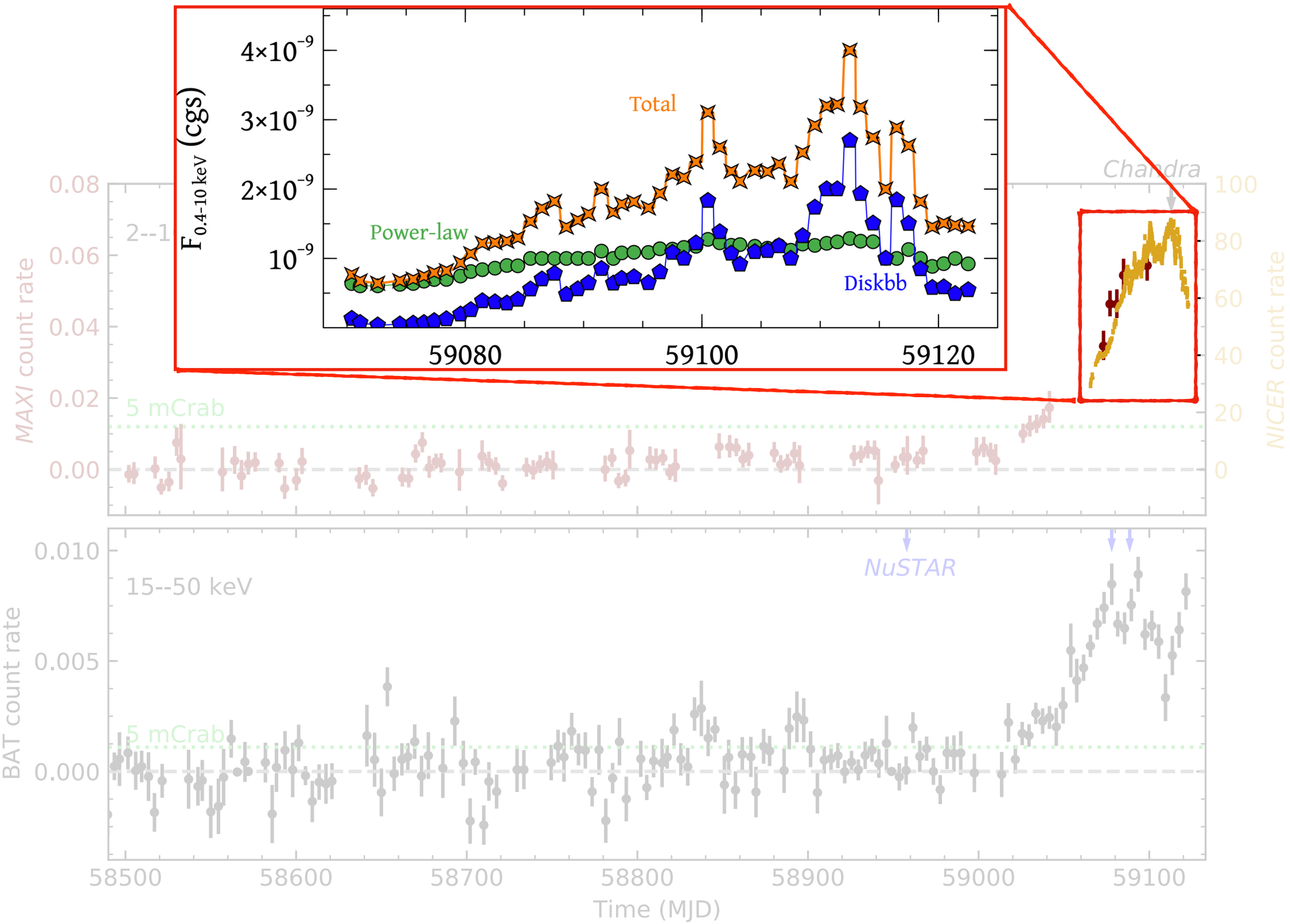

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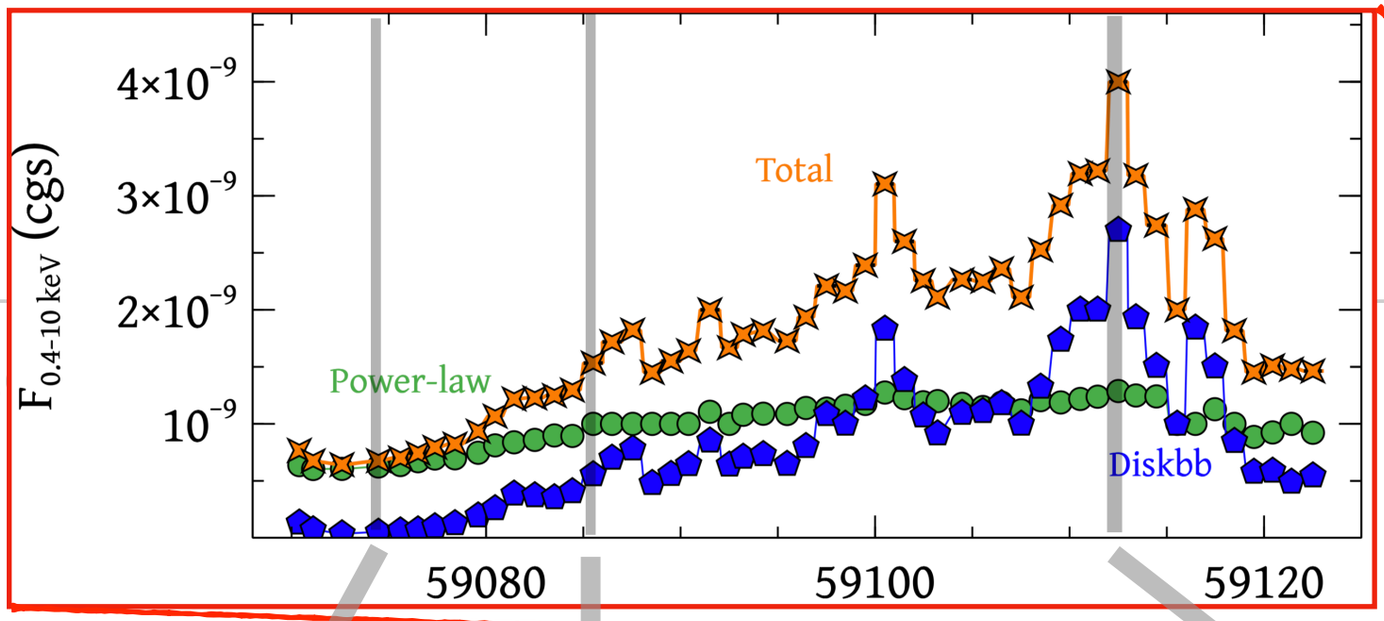


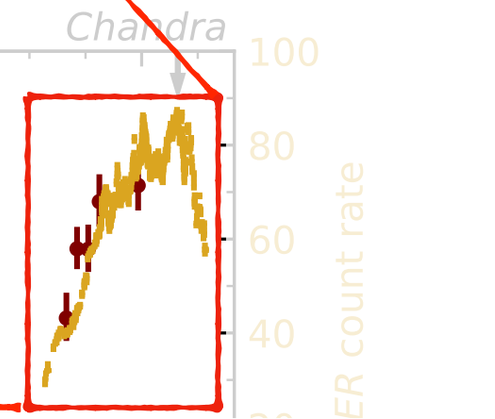


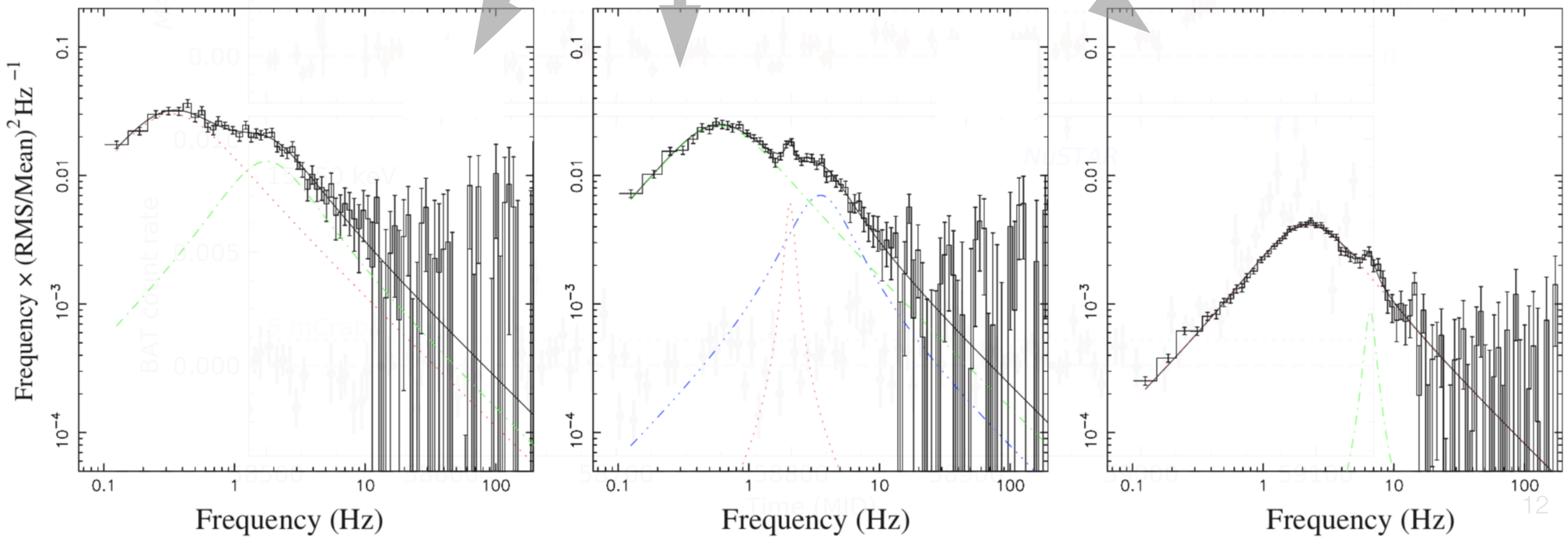

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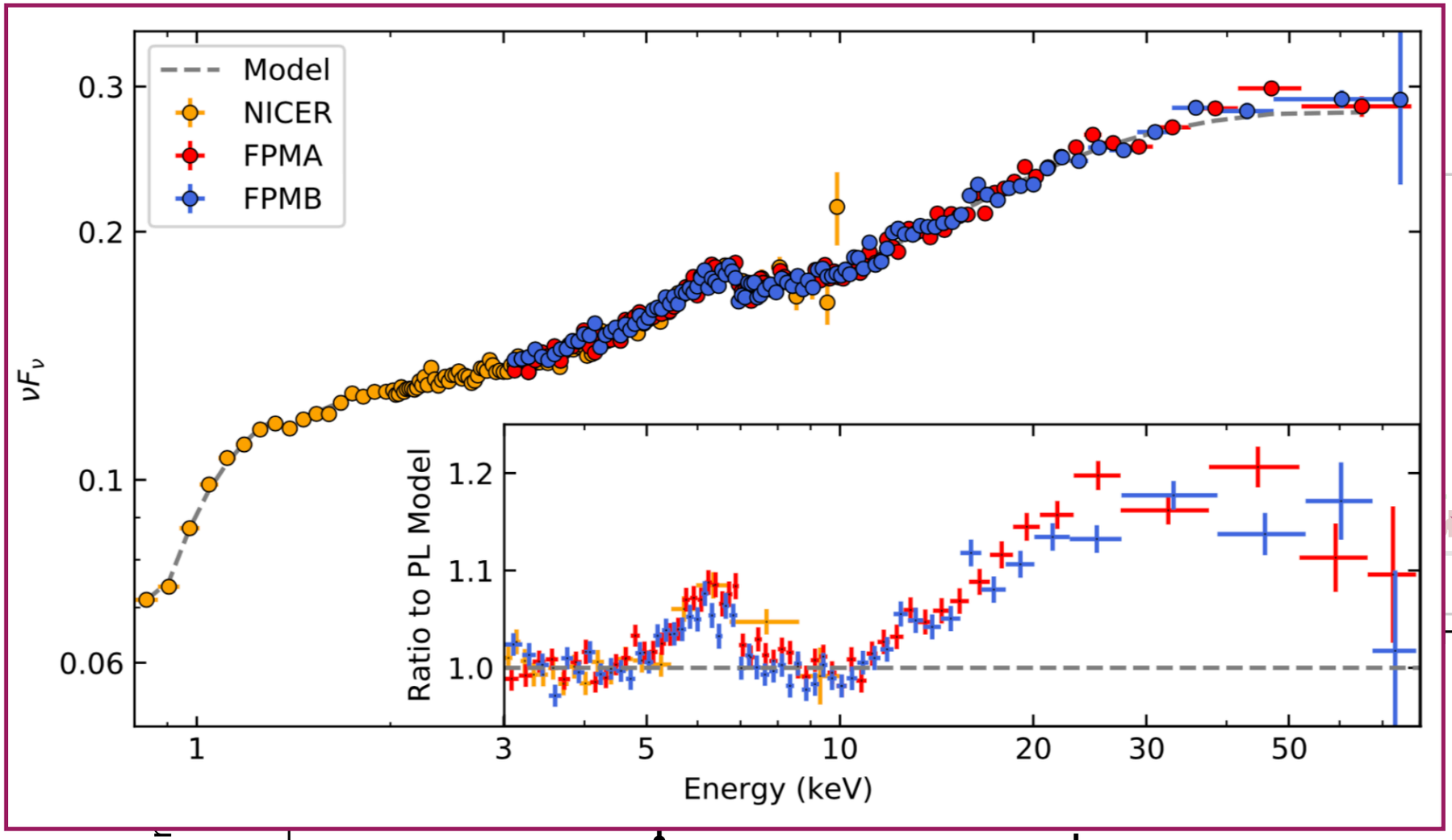


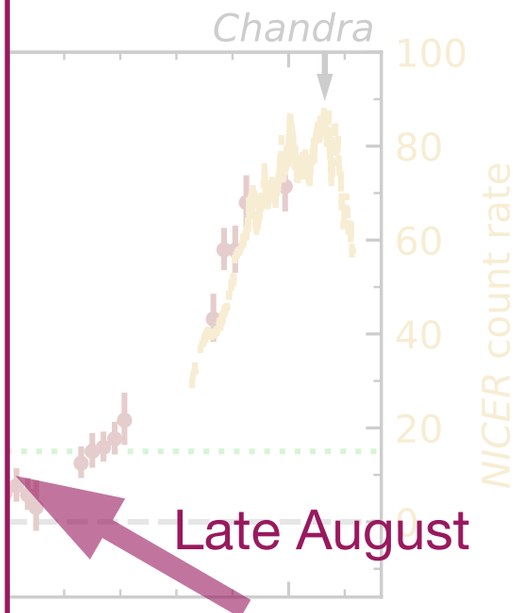


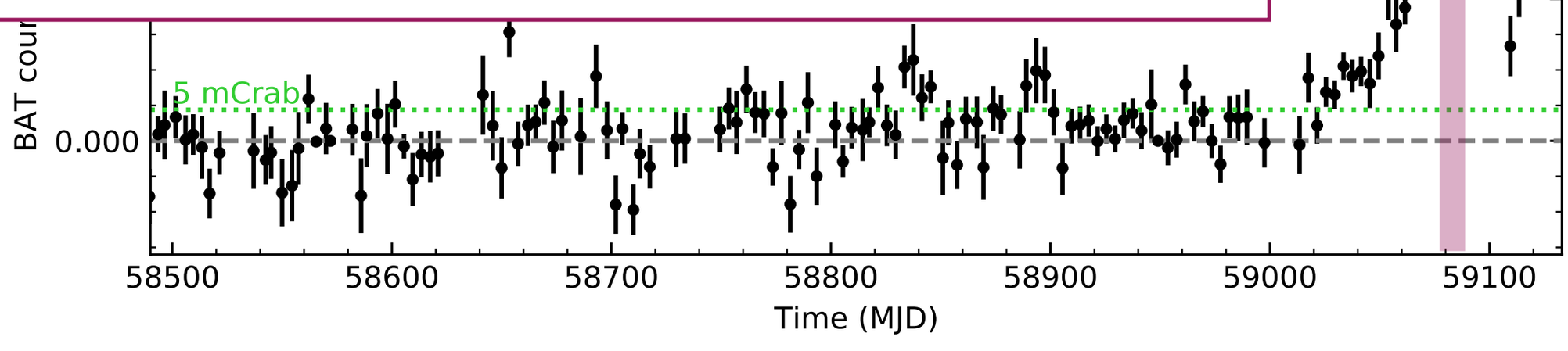

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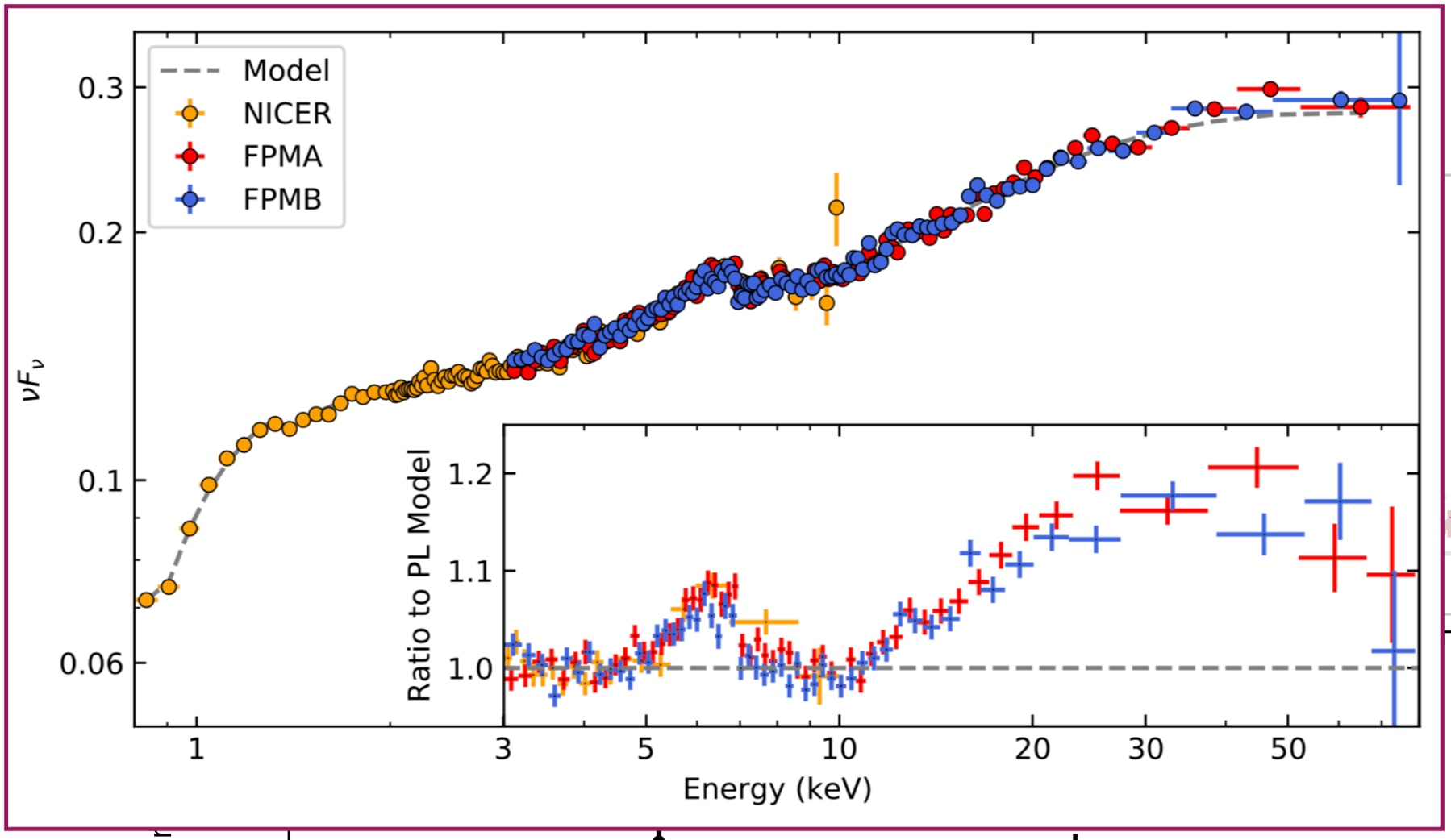
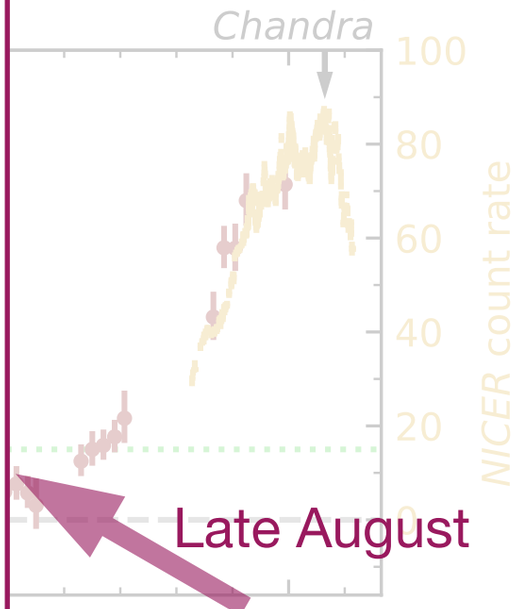
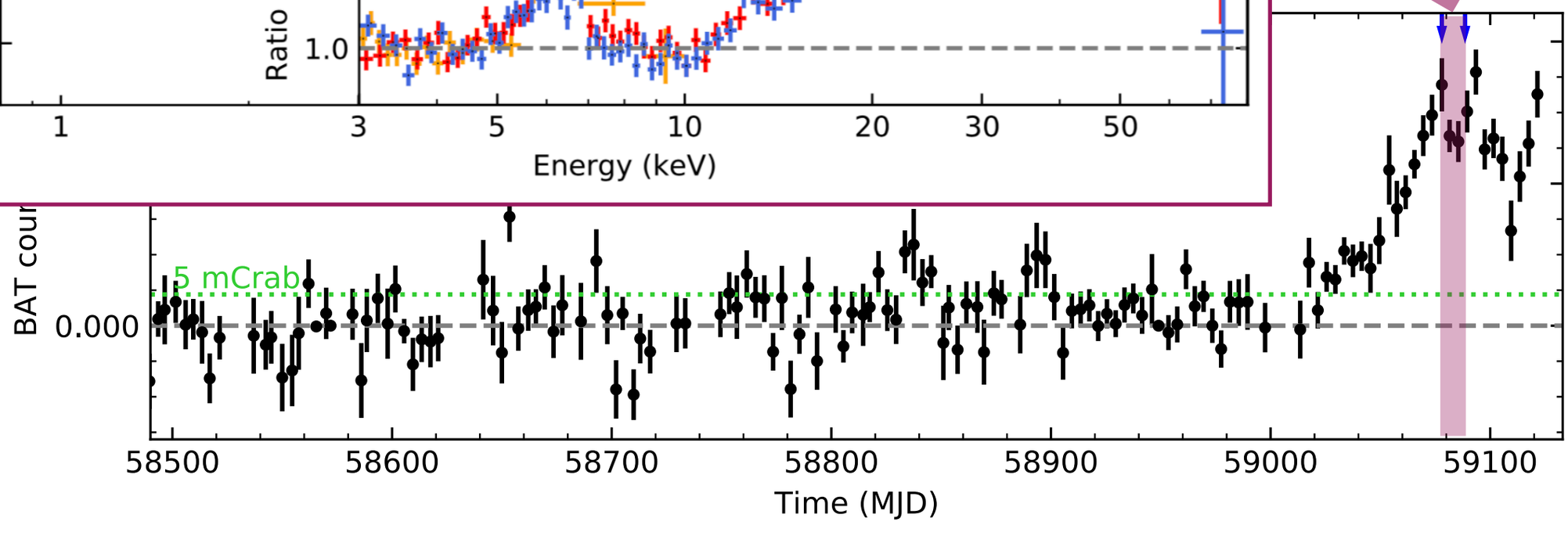
- No cutoff < 300 keV
- No pulsation detection

↓

Probably BH binary

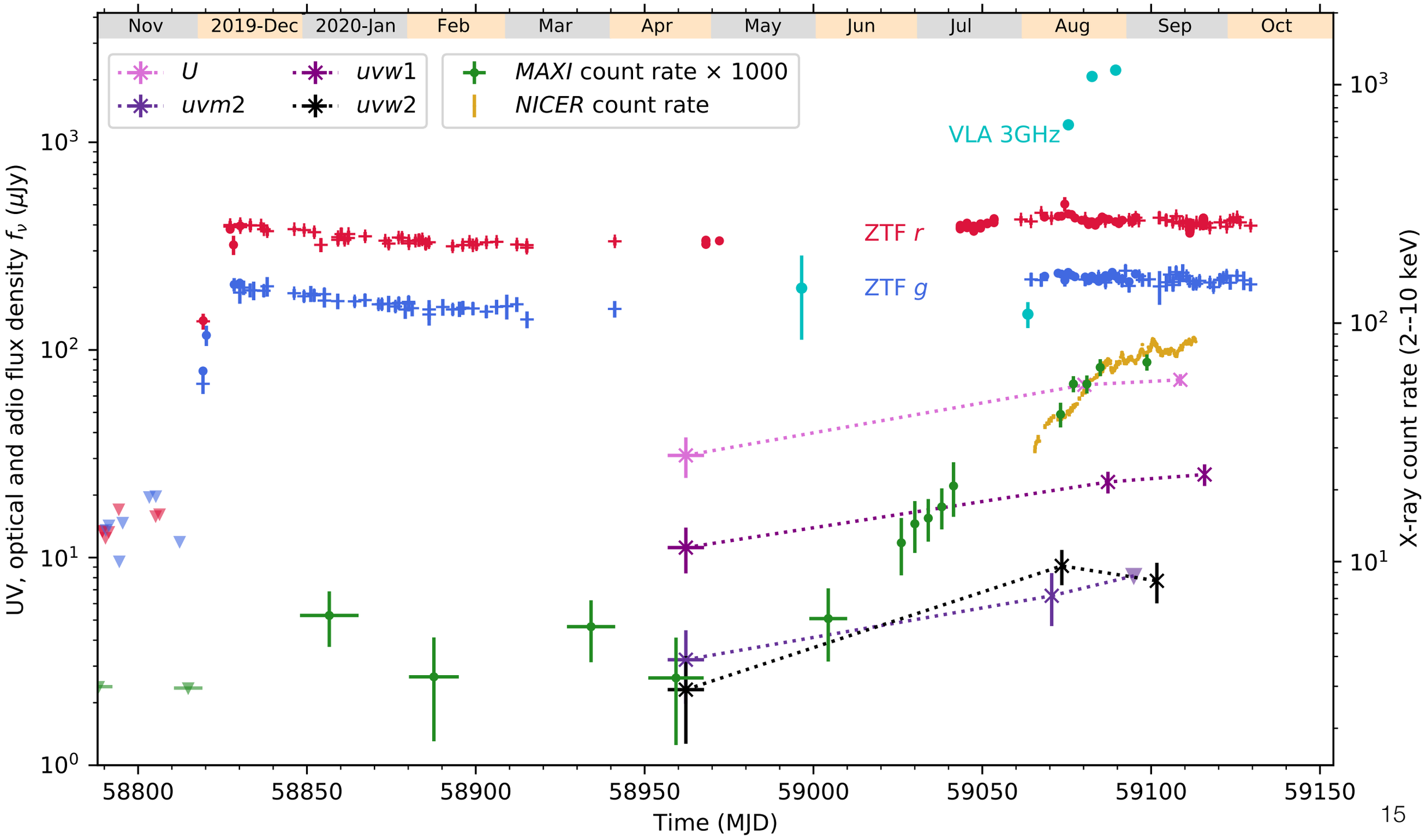


# The *Mysterious* Part:
# Nearly *Constant in Optical* Despite *Significant Brightening in Radio/ X-ray*!!!

Brightening: X-ray↑**>20**, radio↑**>10**, UV ↑**~3**, Opt↑**<1.3**



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- **Uniqueness of AT2019wey:**

  **Very low $L_X$ / $L_{opt}$; Optical is independent from X-ray;**

  **Hard to be explained by irradiation → Truncated disk??**

- **Similarity to known LMXB:**

  **X-ray of AT2019wey has always been in the hard-(intermediate)-state**

  ↓

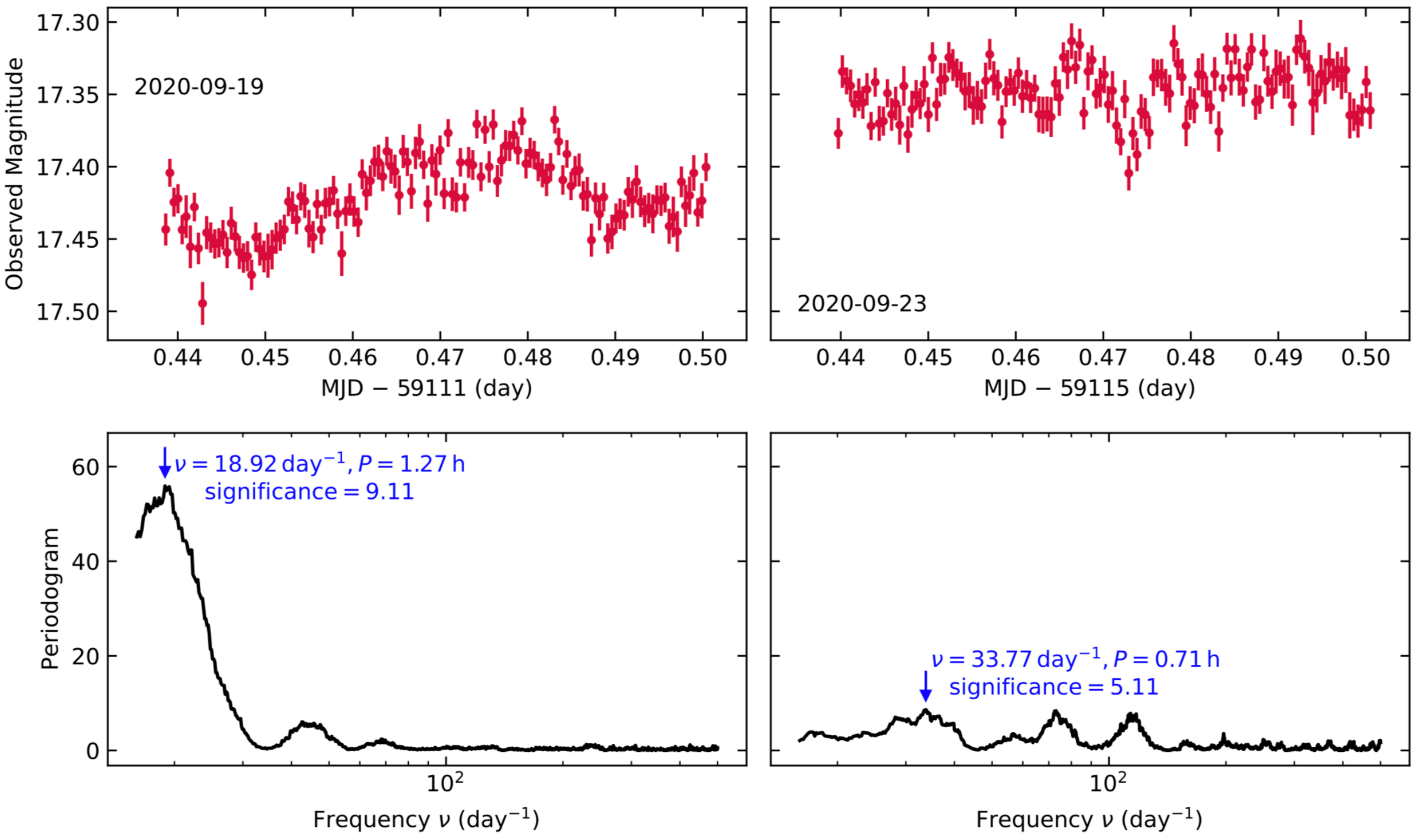
  **Remains at Low-mass Accretion Rate**

  ↓ **Faint quiescent counterpart**

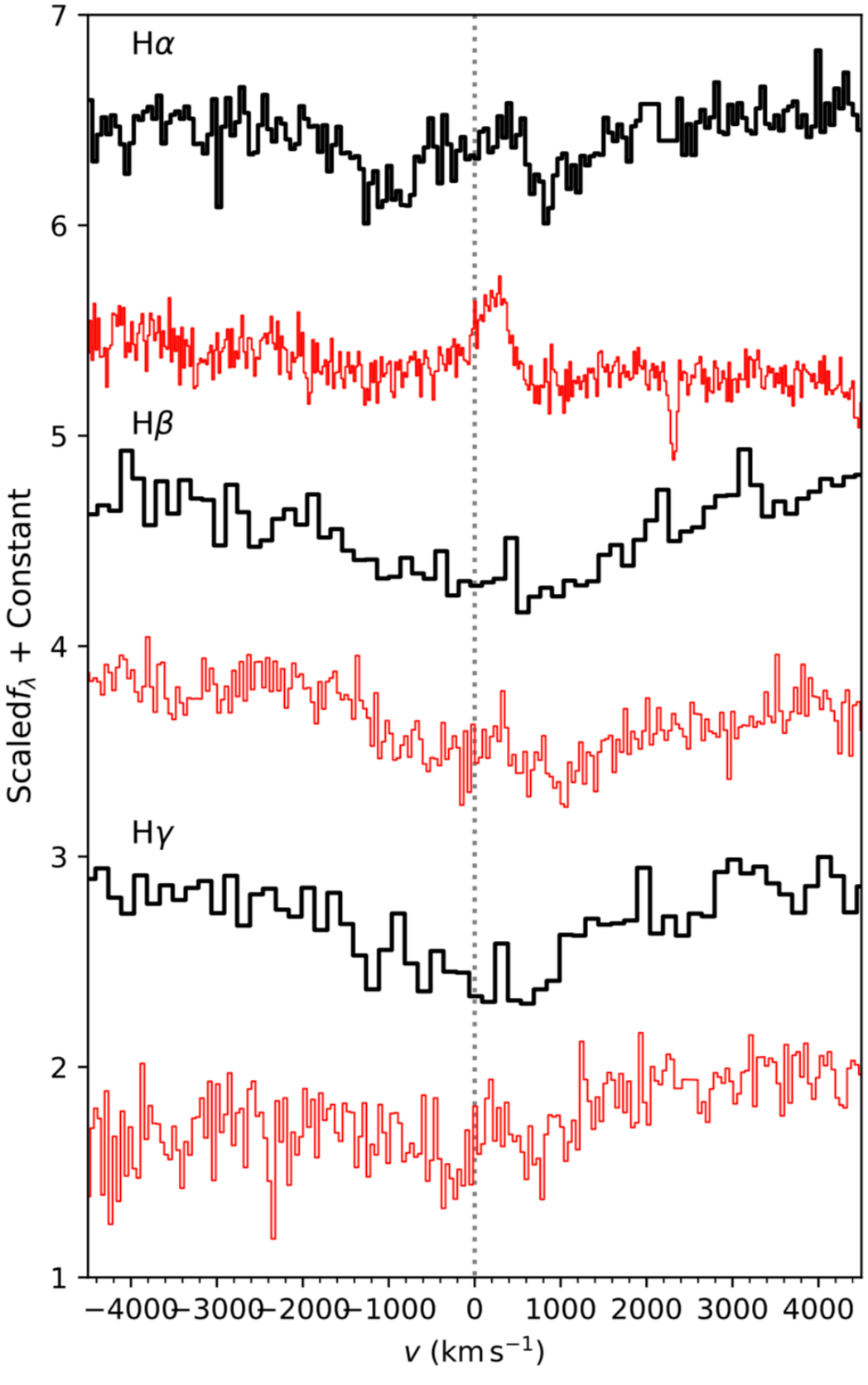
  **Short-period system**

# Orbital Modulation at 1.3 hr? Not conclusive…

ZTF deep drill observation

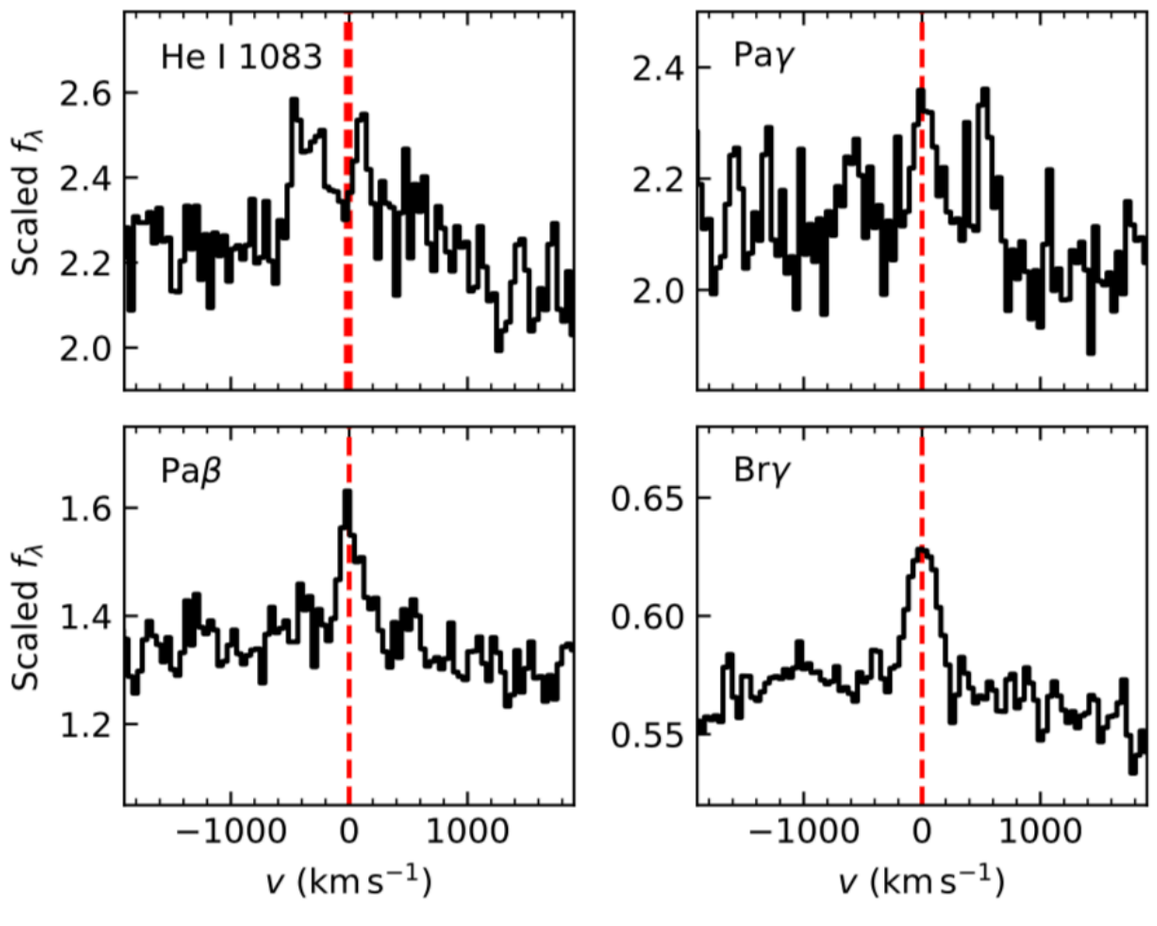


# Optical: Variable Balmer




- Broad emission and absorption lines
- Observed in LMXB BHB & DN

# NIR: Helium and Hydrogen



# Summary

- AT2019wey is a LMXB discovered by ATLAS in optical & *SRG* in X-ray
- Its X-ray spectral and timing properties are consistent with LMXBs
- It has been in the X-ray hard state since discovery
- Its optical emission is independent of X-ray/radio, remained ~constant, which has never been seen in known LMXBs
- Its uniqueness broadens our knowledge for the Galactic LMXB population

*Thank you!*