# The Missing Half: Uncovering the Hidden Population of TDEs



MMS Annual Meeting 2025 HU



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RUB



• TDEs

- a star gets rip apart by the central SMBH's tidal forces

• partial TDEs

- after the initial flare a surviving core/stellar remnant experiences a second (or more) flare • Bowen Fluorescence Flares (BFFs)

- UV bright flares with strong, permanent He II and Bowen lines

- Ambigous Nuclear Transients (ANTs)
  - Unclear extreme nuclear outbursts

- Changing-look AGN
  - Changing-obscuration or Changing-state AGN

 Quasi-Periodic Eruptions (QPEs)

> - periodic soft X-ray flares in galactic nuclei

 Extreme Coronal Line Emitters (ECLEs)

> - galaxies exhibit with highionization coronal lines

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AT2019dsg ATLAS17jrp 2 obscured one

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#### AT2019aalc (Lancel)



- coincidence with IC191119A (van Velzen+24)
- TDE-like flare with large IR dust echo in an AGN
- a second flare occurred in 2023
  - MW monitoring from radio to x-rays





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Accepted proposals: radio monitoring - ATCA radio VLBI - EVN+KVN UV+X-ray - Swift IR - WIRC 5 optical spectra - LRIS, Deveny and DBSP









# Photometric results

- Opt: second flare with bumps and slow decaying (similarly to first)
- UV: larger flare wrt GALEX than 98% of AGN show (Gezari+21)
- x-ray: uniquely soft, reoccurring flares
- IR: accompanying flare due to dust echo
- **radio:** long-term flare started between the opt. flares



Veres+24

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- strong Balmer lines, later times double-peaked

- Bowen fluorescence lines

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  - strong Balmer lines, later times doublepeaked
  - Bowen fluorescence lines
  - high-ionization coronal lines
- **radio**: turnover in the spectrum
- x-ray: 'supersoft'



Veres+24

#### Classification

- Spectroscopy: Bowen fluorescence lines, supersoft in x-ray
- **Photometry:** UV bright opt. transient, late-time x-rays

#### Bowen Fluorescence Flare

- **Spectroscopy:** high-ionization coronal lines
- **Photometry:** IR dust echo

Extreme Coronal Line Emitter

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### QPE?

- Quasi-Periodic Eruptions (QPEs) in Xray have been detected in 8-10 objects including AT2022upj (Chakraborty+25) which is reminiscent to a BFF
- some QPEs are promising gravitational wave sources (Sukova+24)
- cases of the BFFs AT2020afhd and Lancel



AT2020afhd





Chakraborty+25

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#### BFF+ECLE+QPE=TDEinAGN

- ionization source: accretion disc
- the soft x-ray flares power
- accretion disk stellar debris interaction as origin of reoccurring soft x-ray flares

- consistent with TDE-AGN simulations (Chen+19, Liu+24, Ryu+24)



### **BFF+ECLE+QPE=TDEinAGN**

- <u>double-peaked</u> Balmer lines seen in the late-time spectrum of Lancel
- similar feature in other BFFs
- TDE AT2018hyz: the low optical depth of material due to a possible partial disruption is what allows us to observe these double-peaked lines (Short+20) → consistent with our partial TDE scenario









Veres+24

more about the neutrino emission of AT2019aalc: Pavlo+24 (arXiv:2410.19047)



# We observe more BFFs



#### Summary

- we classify AT2019aalc as BFF and ECLE

- we connect 2 new classes of flaring SMBH: BFFs and ECLEs (+QPE?)

- we propose 'partal TDE in AGN' scenario to explain these transients

future:

- late-time observations will tell us more about the TDE's impact on AGN's life

- new candidates (potentially with LS4)

