



STONKS

& other long-term variability adventures

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I. GEORGANTOPOULOS, M. GUPTA, A. SCHWOPE, I. TRAULSEN, & others

I.

Context &
Method

II.

Data
Mining

III.

Transient
Alerts

I.

Context &
Method

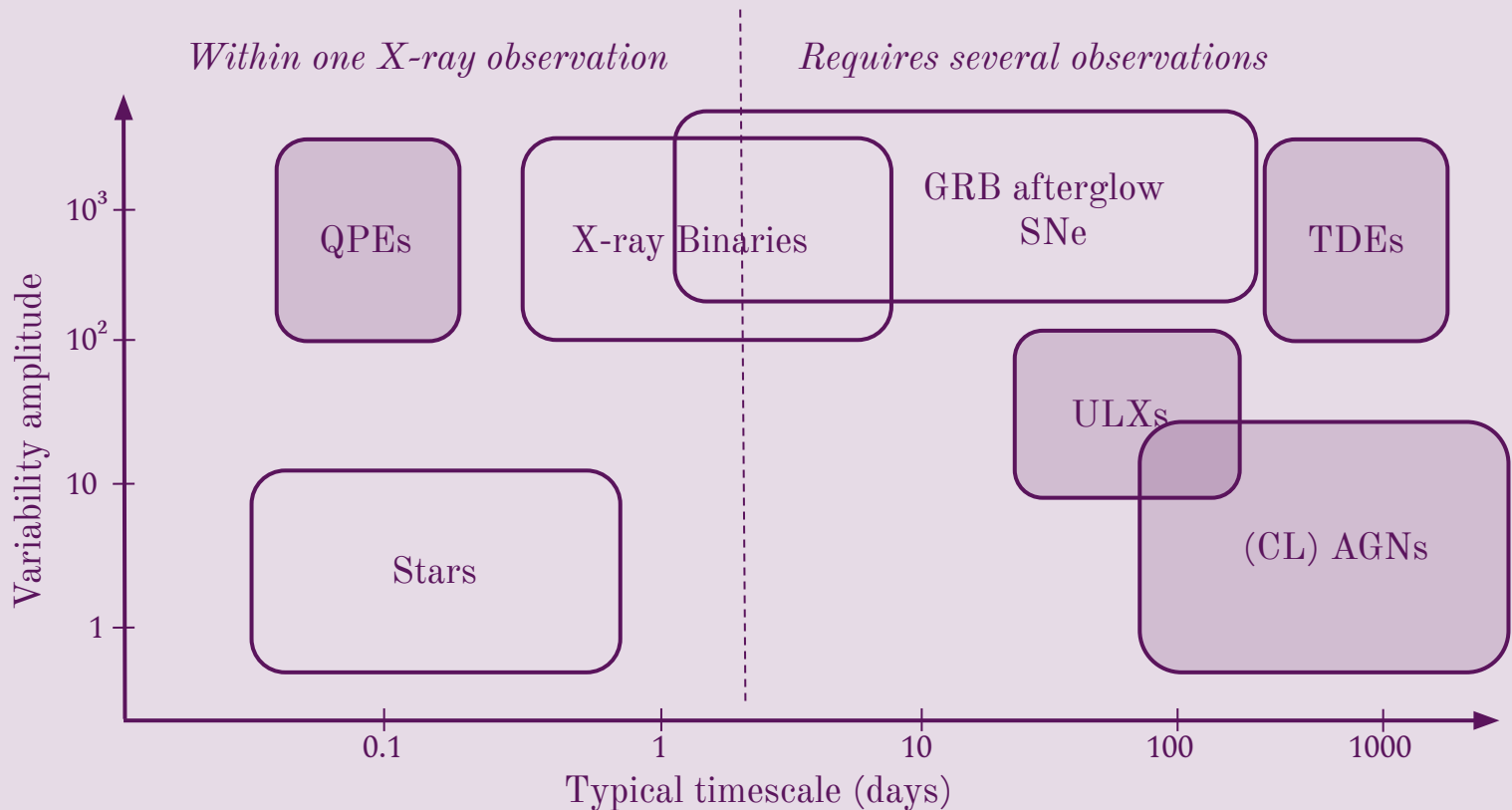
II.

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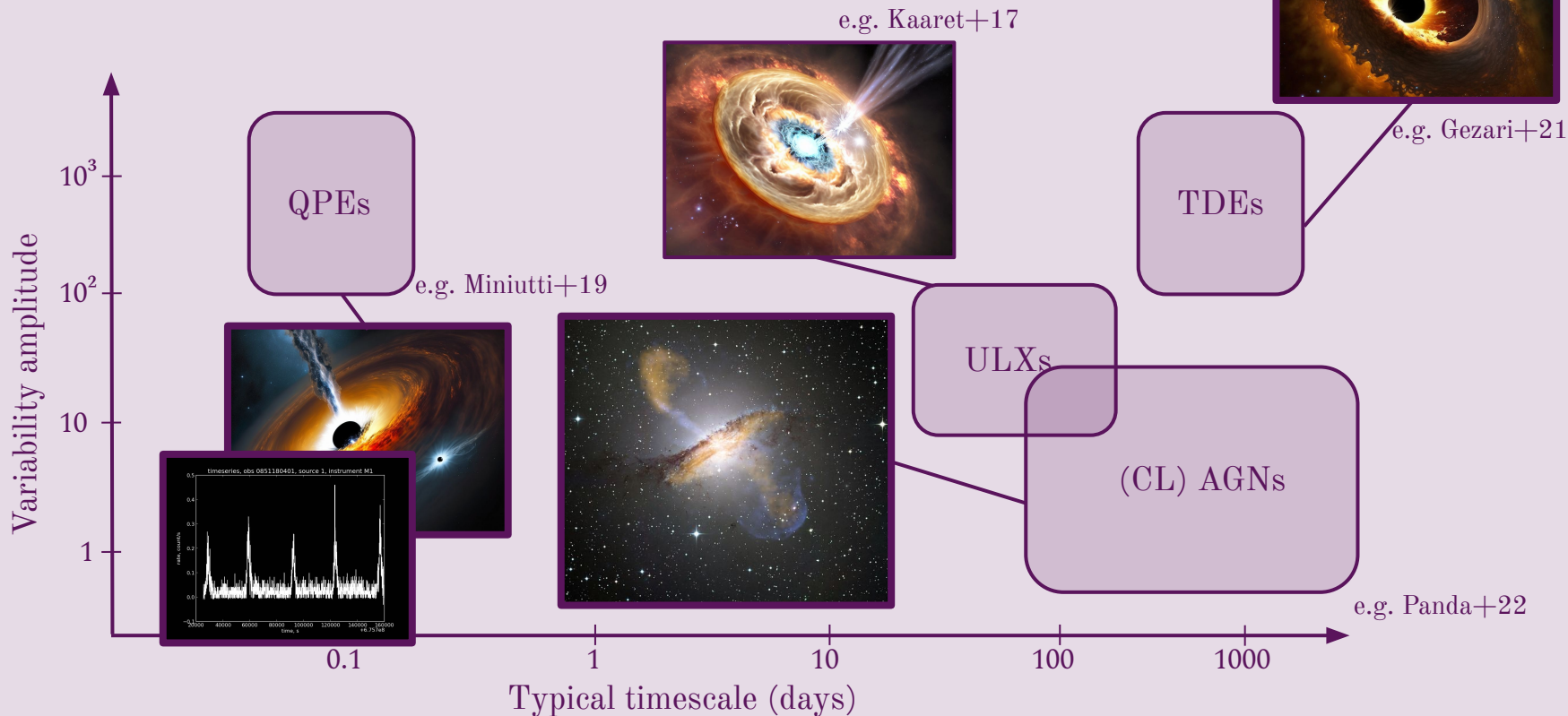
A quick view of the X-ray transient sky



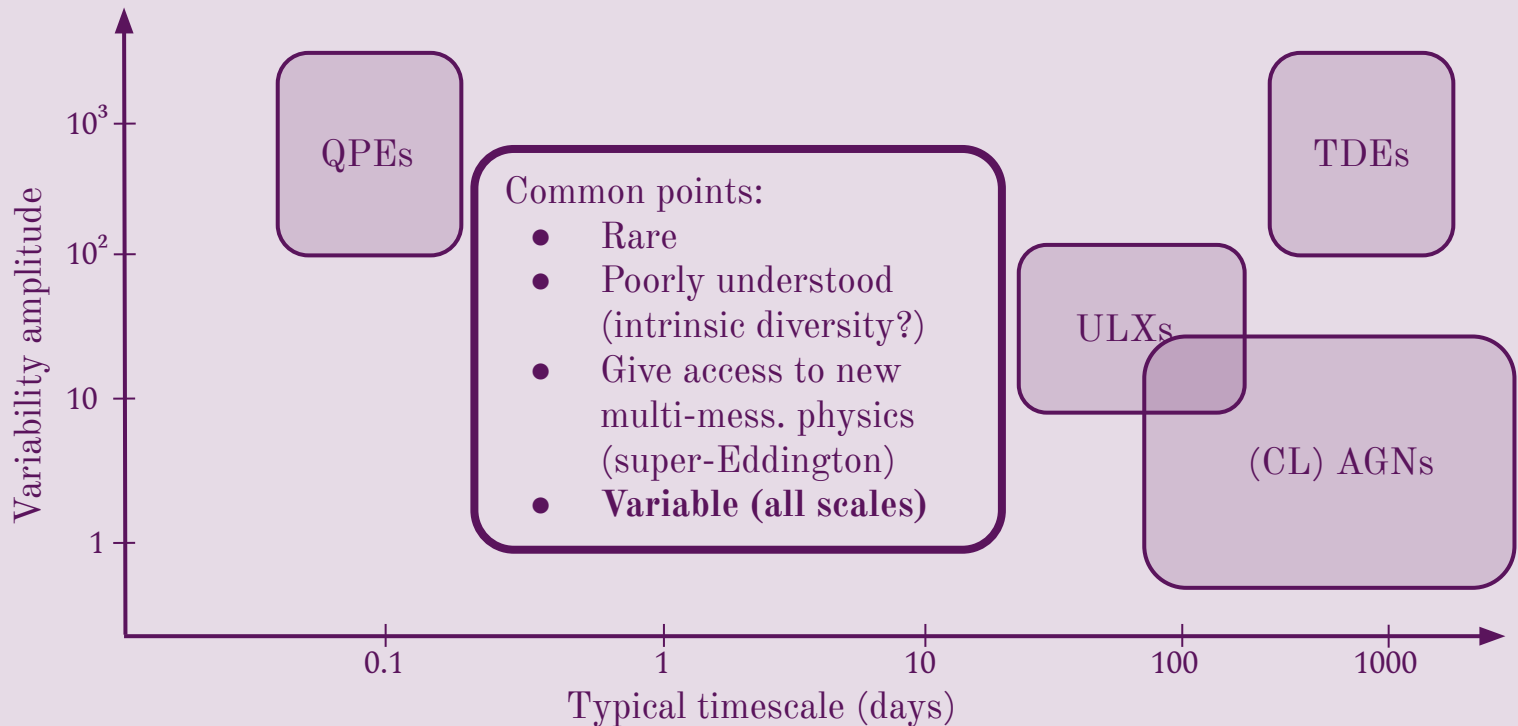
A quick view of the X-ray transient sky



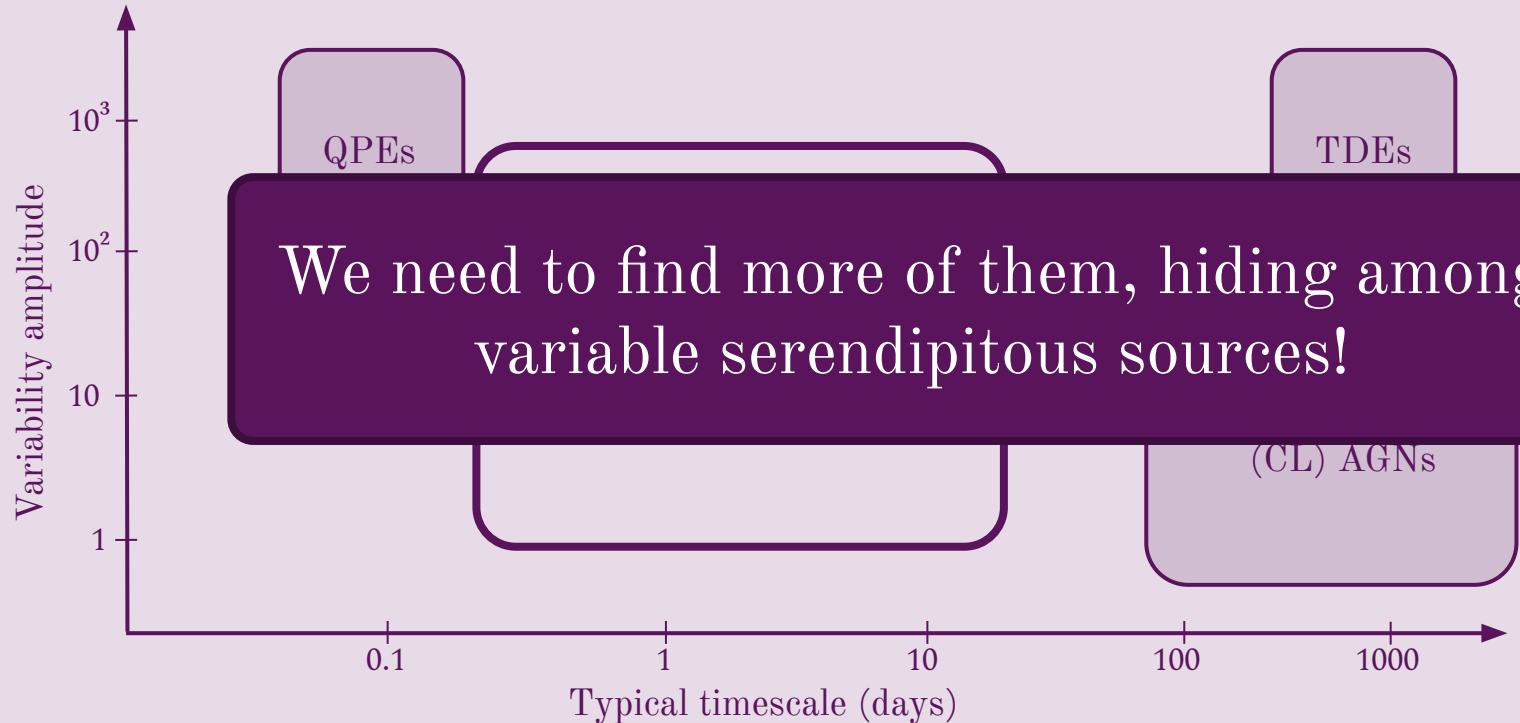
e.g. Gezari+21



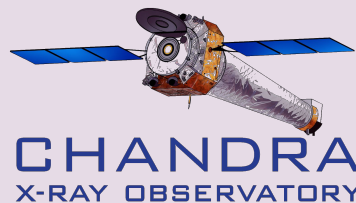
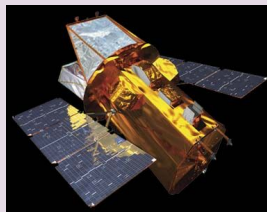
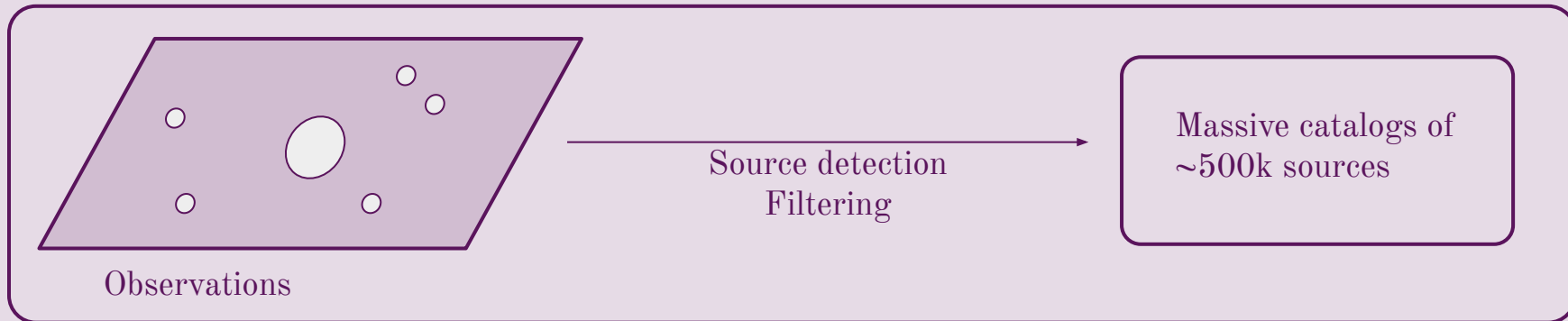
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A quick view of the X-ray transient sky



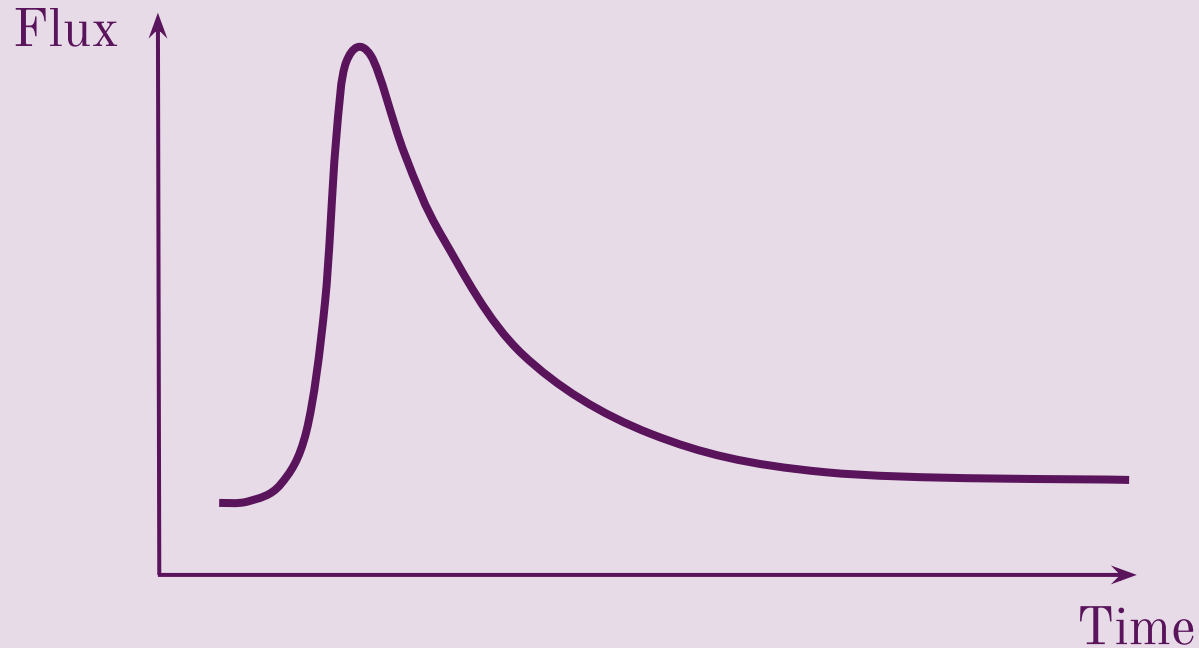
What happens to serendipitous sources ?



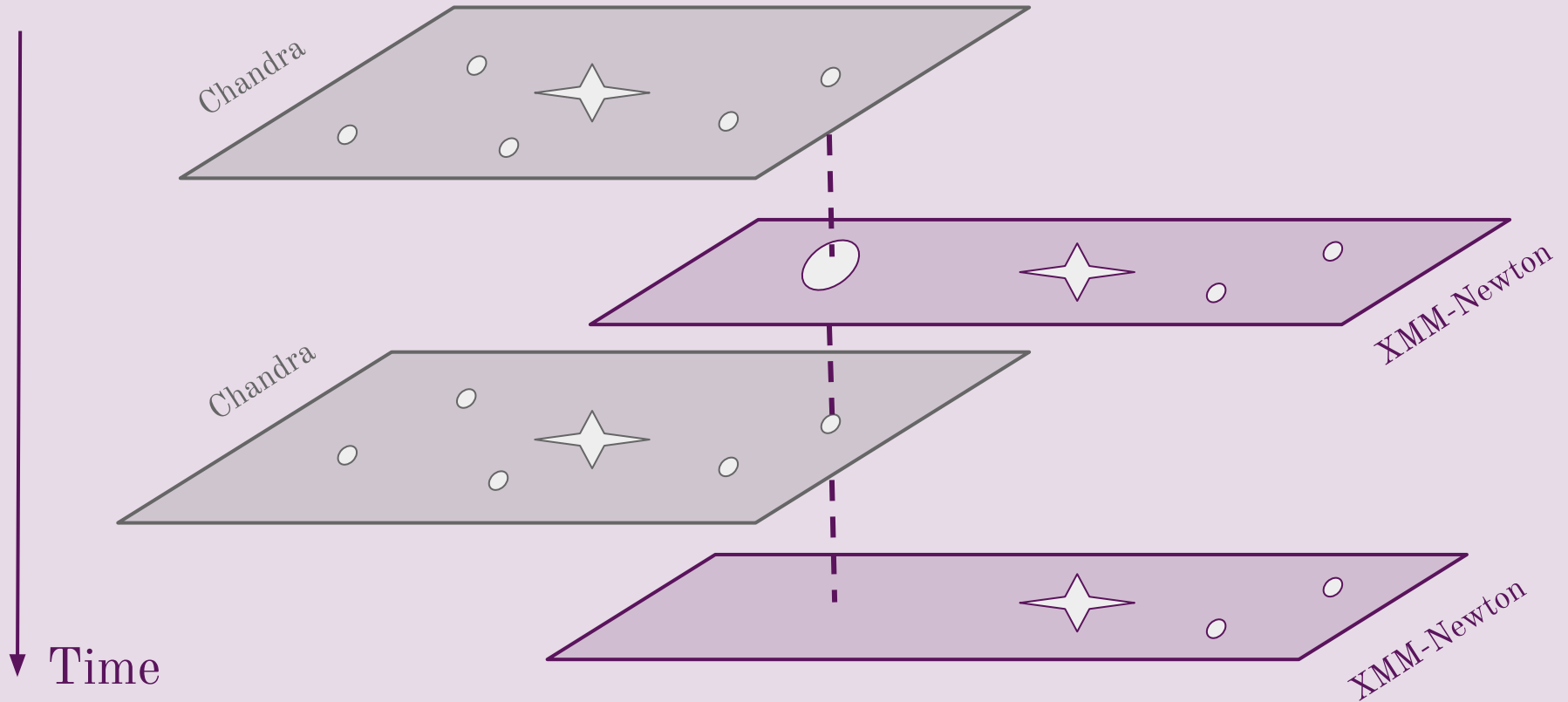
Rarely systematically exploited, and even more rarely compared



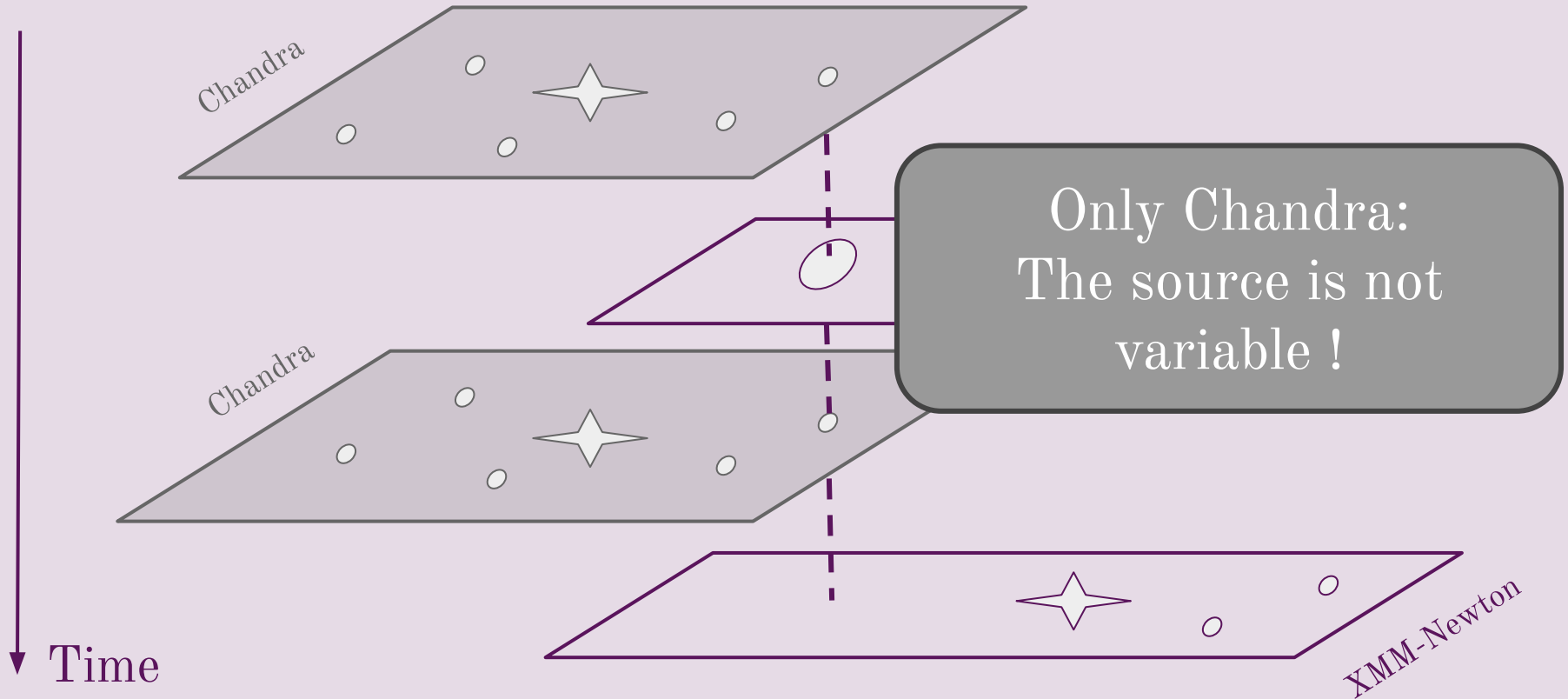
A typical transient lightcurve



Several observations by X-ray telescopes



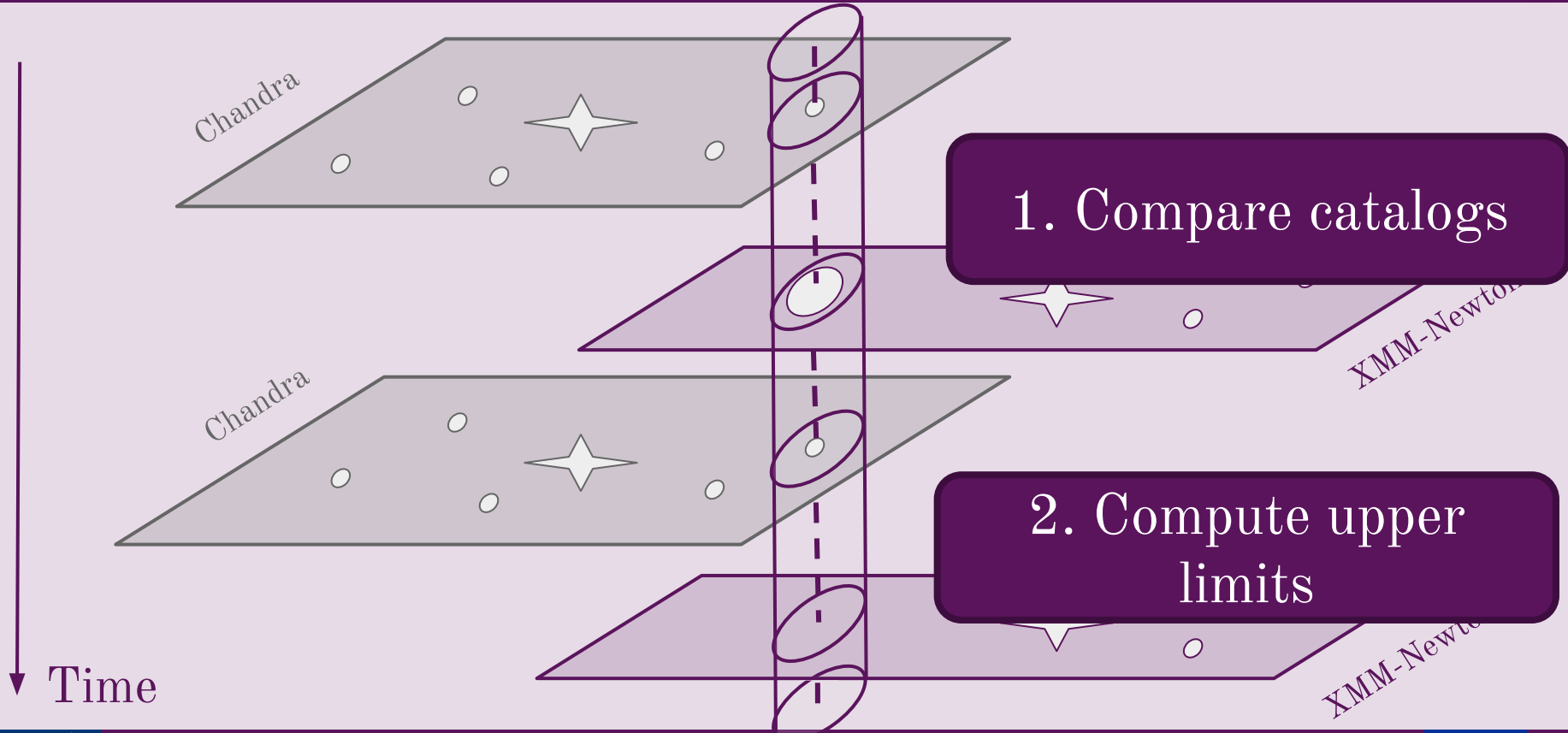
Several observations by X-ray telescopes



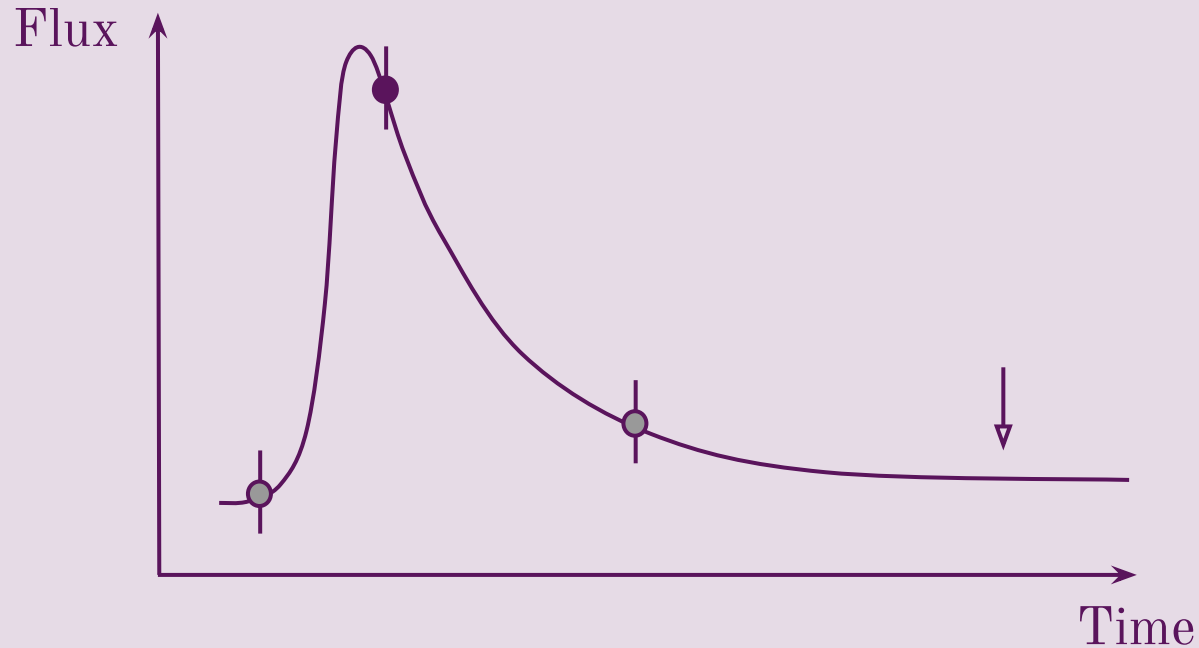
Several observations by X-ray telescopes



Several observations by X-ray telescopes



Allows to constrain the complete lightcurve



Method: X-ray catalogs

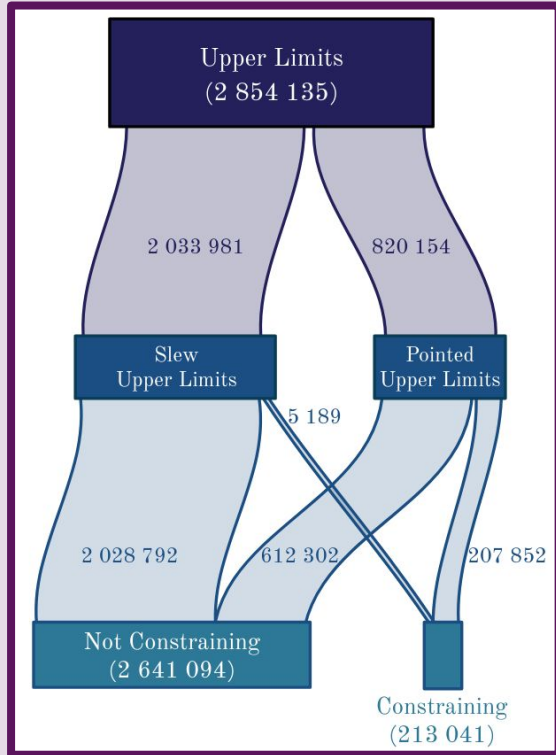
	Number of Sources	Sensitivity	Spatial resolution	Coverage	
XMM-Newton Pointed	575 k	+	+	=	Webb et al. (2020)
Chandra	300 k	++	++	-	Evans et al. (2020)
Swift	200 k	=	=	+	Evans et al. (2020)
XMM-Newton Slew	30 k	-	-	++	Saxton et al. (2008)
XMM-Newton Stacked	90k new sources	+	+	=	Traulsen et al. (2019)
ROSAT	60 k (survey) 60 k (pointed)	-	-	++	White et al. (1994) Boller et al. (2016)
Early eROSITA	20 k	+	+	-	Salvato et al. (2021)

Method: X-ray catalogs

	Number of Sources	Sensitivity	Spatial resolution	Coverage	
XMM-Newton Pointed	~550 k	++	++	++	Webb et al. (2020)
Chandra	~100 k	++	++	+	Evans et al. (2020)
Swift	~100 k	++	++	++	Evans et al. (2020)
XMM-Newton Slew	~100 k	+	+	++	Saxton et al. (2008)
XMM-Newton Stacked	~100 k	+	+	++	Traulsen et al. (2019)
ROSAT	60 k (survey) 60 k (pointed)	-	-	++	White et al. (1994) Boller et al. (2016)
Early eROSITA	20 k	+	+	-	Salvato et al. (2021)

About 1M X-ray sources
Multi-instrument for 15%

Method: Upper limits



Computed with RapidXMM
(Ruiz+21)

~600 k sources, ~100k not in XMM

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Result: Large archival catalog

About 1M X-ray sources
Multi-instrument for 15%

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Available Properties

- Variability
- Position
- All fluxes
- Band photometry
(spectral shape)

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Additional Properties

- Simbad
- Classification
- Multi-wavelength
variability

Add clever selection criteria on these properties:

Available

properties

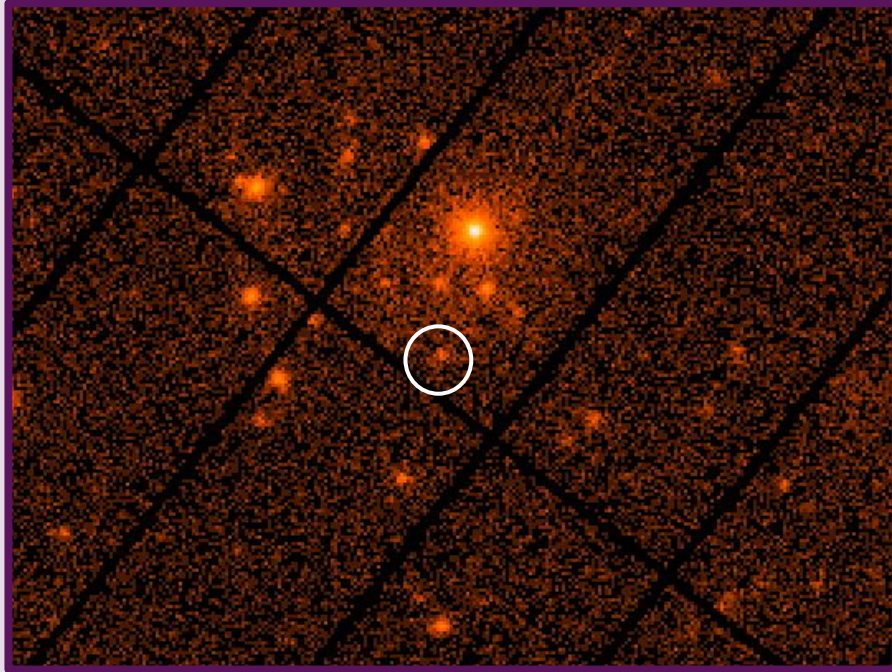
- Variability
- Position
- All fluxes
- Band photometry (spectral shape)
- Multi-wavelength variability

Find new sources !

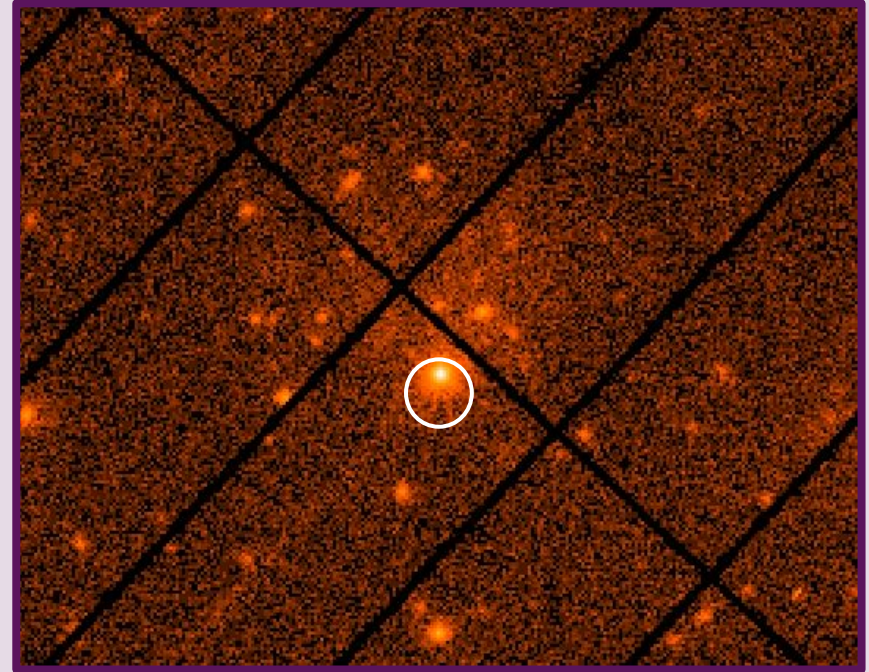
Criteria

- Long-term variable
- In the extent of a galaxy
- Peak luminosity $> 3 \times 10^{39}$ erg/s

Datamining #1: new transient ULX

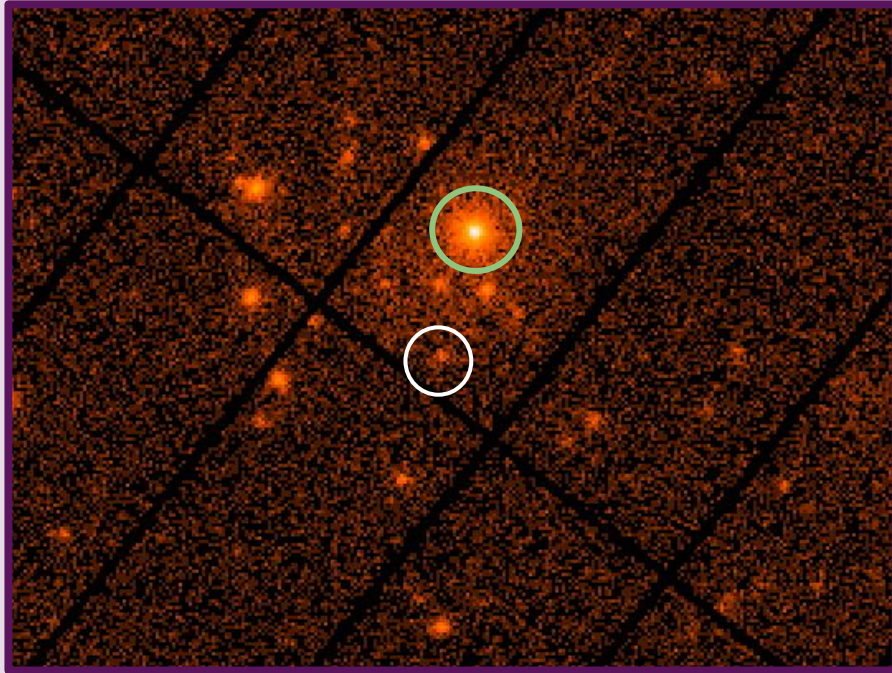


May 2012



November 2013

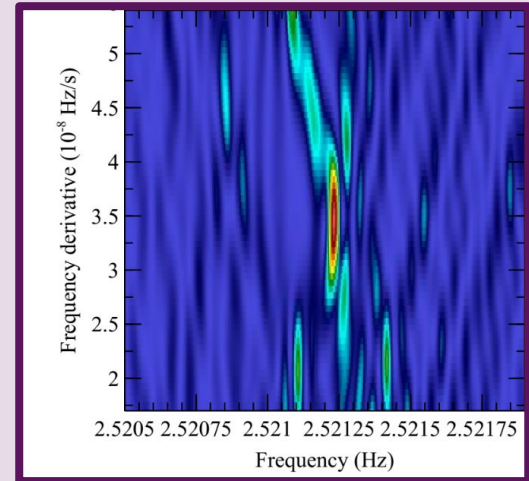
Datamining #1: new transient ULX



May 2012

A new transient ULX

8th candidate PULX
(Quintin et al. 21)

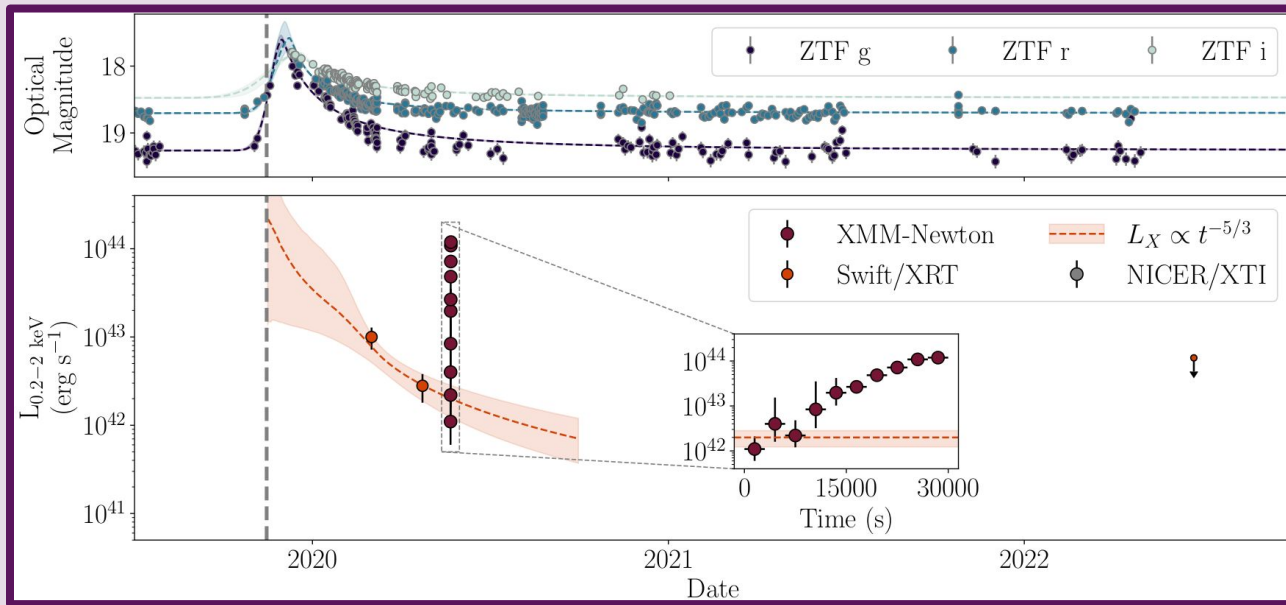


Criteria

- Short-term variable
- At the center of a galaxy (GLADE+)
- Peak luminosity $> 10^{41}$ erg/s
- Soft spectrum

Datamining #2: new QPE candidate

All known QPEs + AT2019vcb (‘Tormund’)



6th QPE candidate
First with optical TDE

Quintin+23

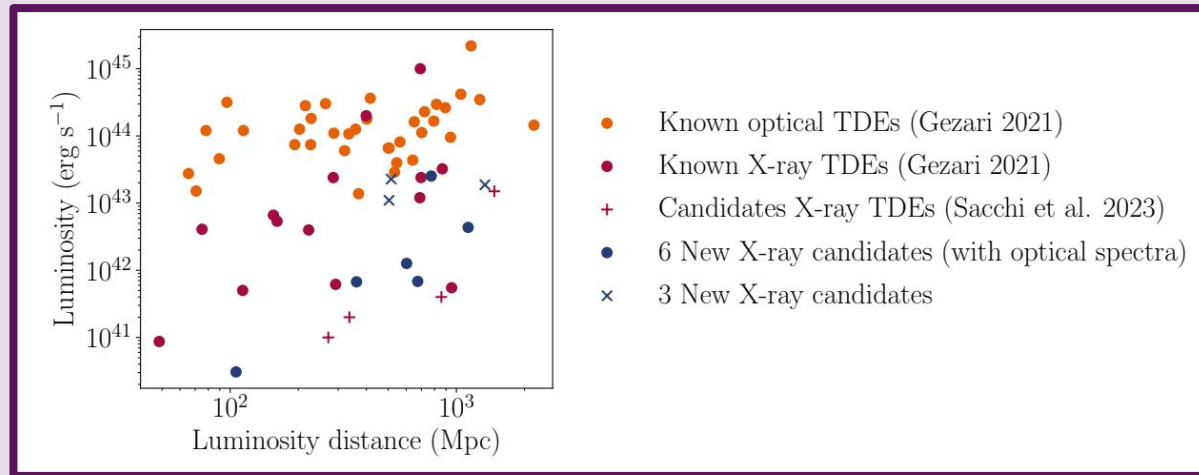
Criteria

- Long-term variable
- At the center of a galaxy (GLADE+ & Gaia)
- Peak luminosity $>10^{41}$ erg/s
- Soft spectrum

Almost all known X-ray TDEs

9 new candidates

- 6 have optical spectra - passive
- 3 have large variability



Quintin et al., in prep.

Conclusion of datamining

Great to see them now...

Great to see them now...



I.

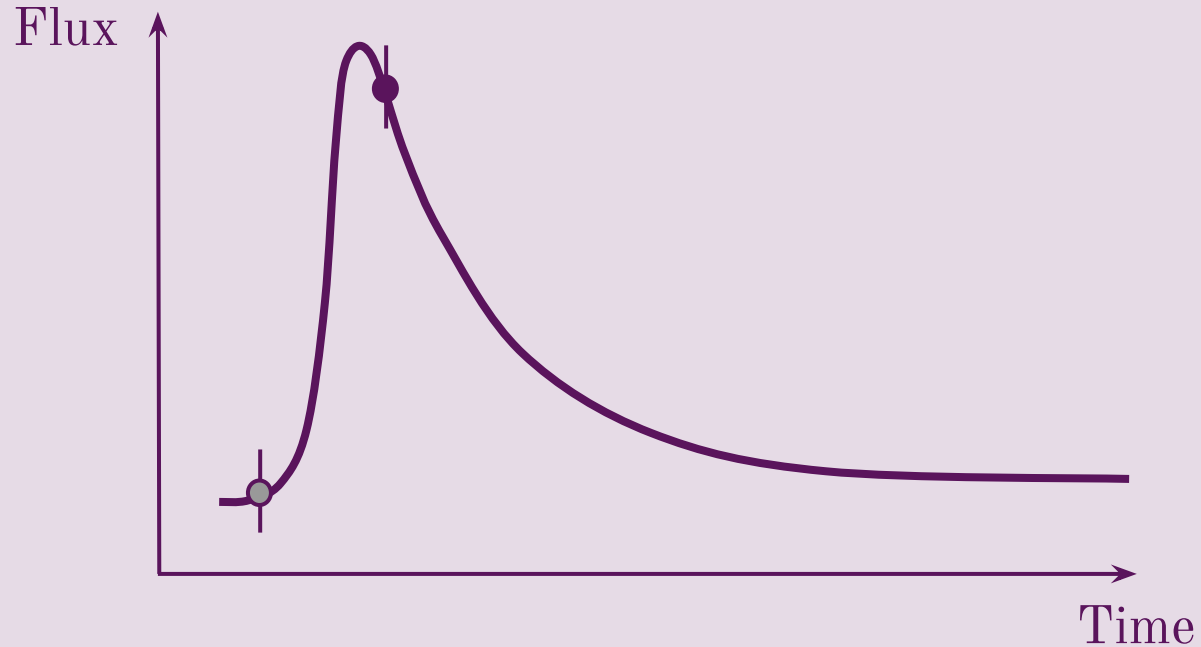
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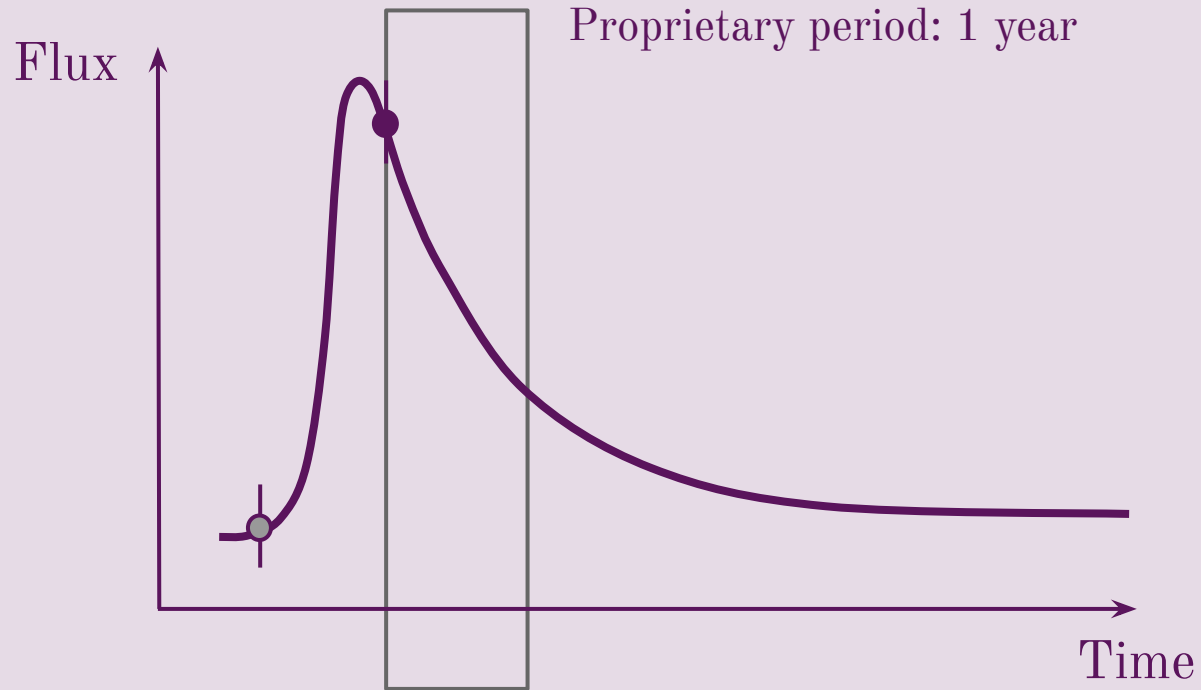
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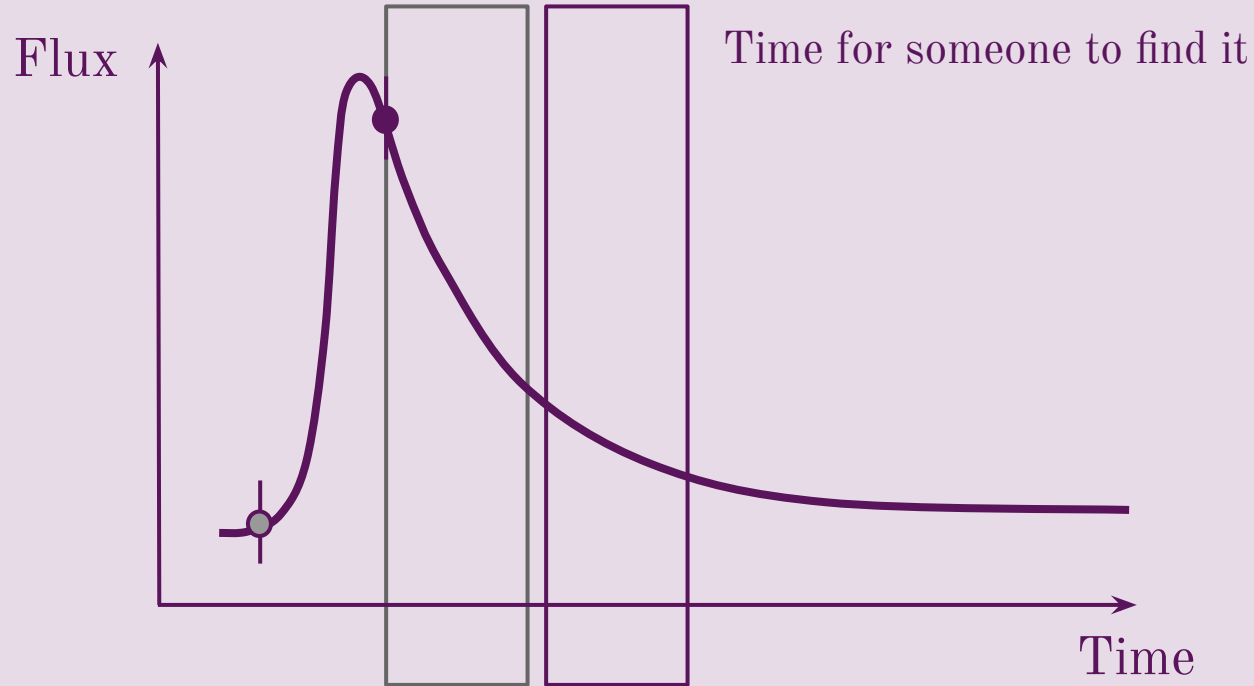
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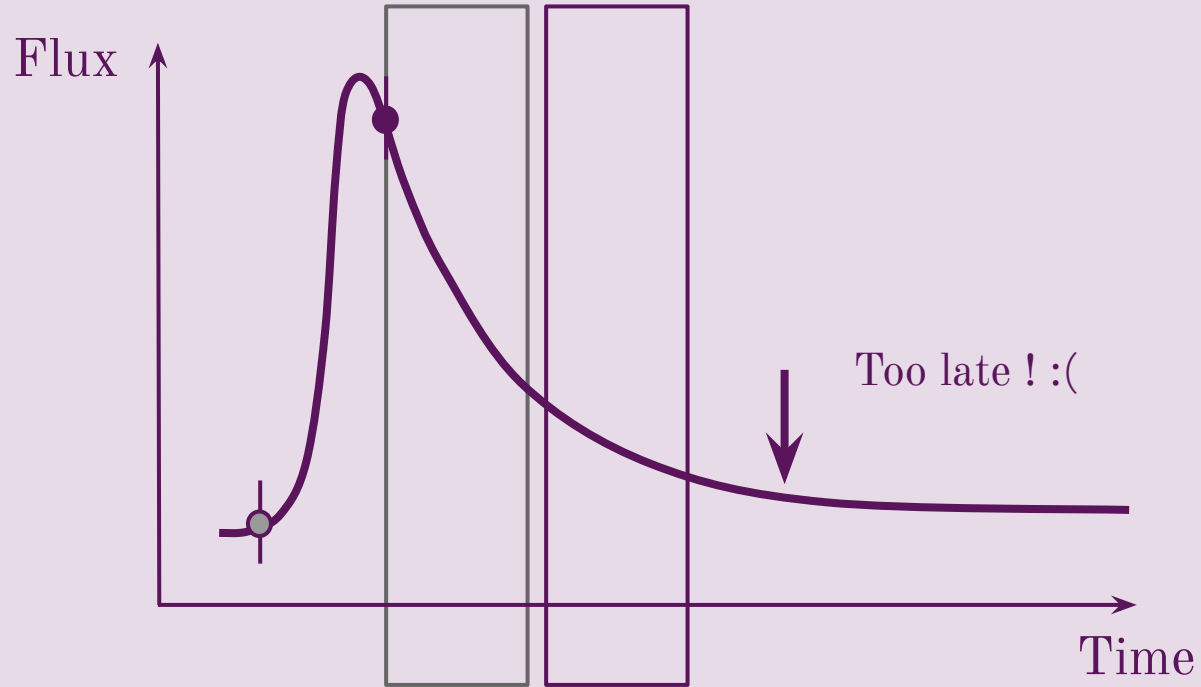
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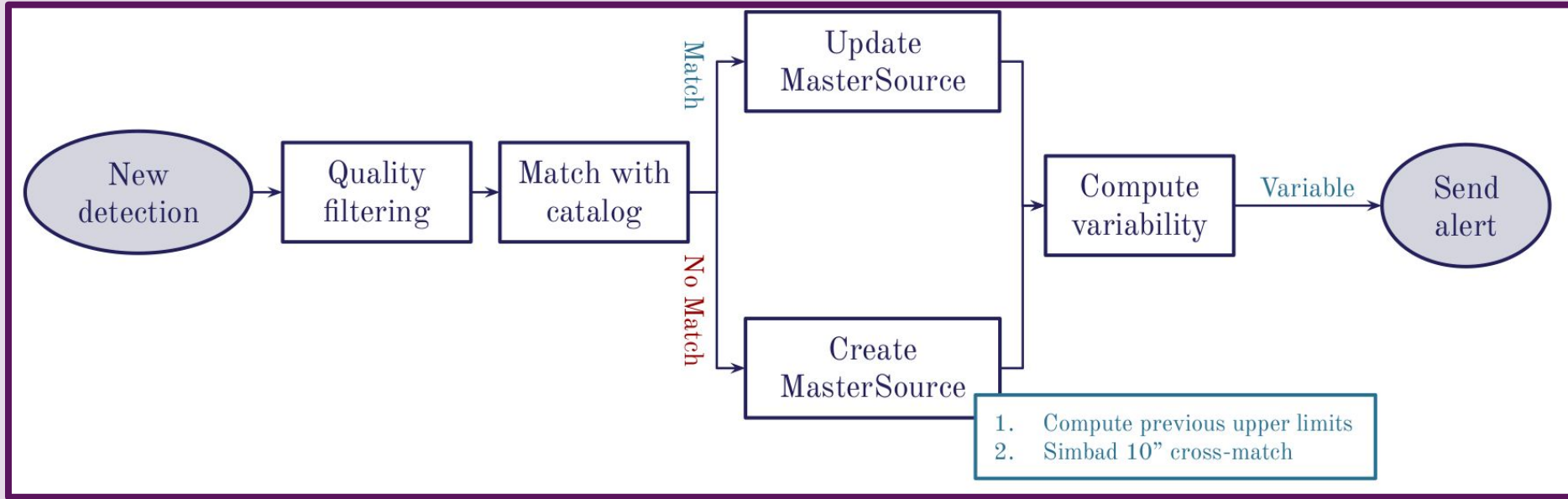
Search for
Transient
Objects in
New detections using
Known
Sources



- Check variability from catalog / upper limits for new **serendipitous** detections
- Send it to the P.I.
- If they agree, sent out to community

Quintin et al., submitted

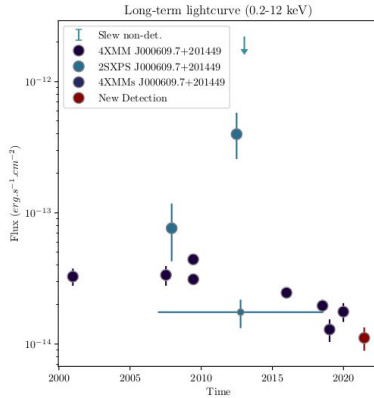
The STONKS algorithm



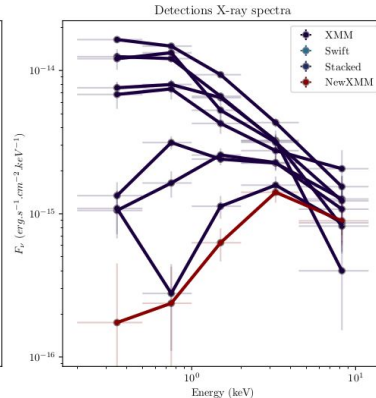
Already deployed, currently being tested at CDS
(Laurent MICHEL- <https://xcatdb.unistra.fr/stonks/>)

The STONKS algorithm

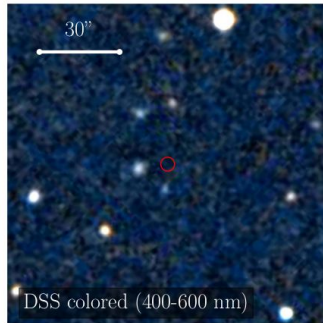
Multi-instrument
X-ray lightcurve



Multi-instrument
X-ray spectra



Optical view



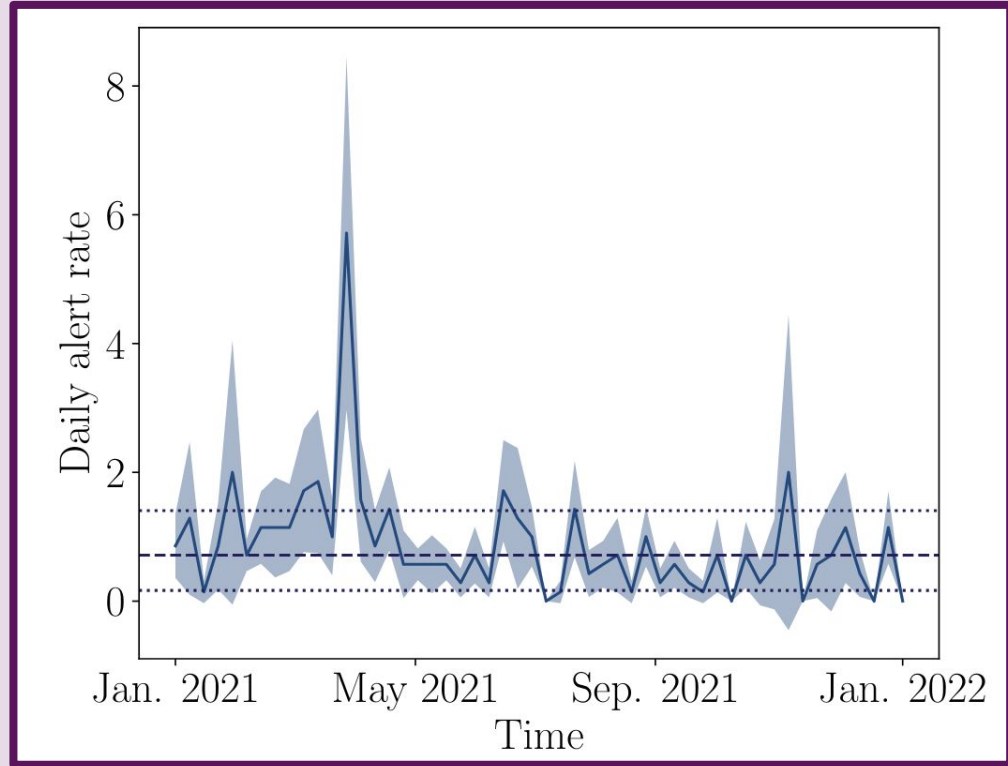
Additional info



ObsID	0842760201
Date Obs	2021-06-16T06:36:33
Target Name	Mrk 335
Exposure Time	87336 s
SRCNUM	61
Source RA	1.54 / 00:06:09
Source Dec	20.25 / +20:14:49
Position Error	0.86"
Off-axis Angles	PN: 3.6', M1: 3.3', M2: 2.3'
Instruments DetML	
	PN: 25.6, M1: 13.5, M2: 15.6, EP: 52.5
Type of Alert	Low Flux State
Long-term Variability	19.2
Short-term Variability	False
Simbad	Galaxy (SDSS J000609.72+201450.1)

The STONKS algorithm: expected results

About 0.7 alerts per day



- Swift / XMM-Newton follow-up
- Multi-wavelength study
- LSST brokers (e.g. Fink)
- ?

Your turn !

For now: run on Heritage
program, no proprietary period

In the future: a box to check in
phase 2

Hypothetical ←

Conclusion

Method: Multi-instrument catalog

Application #1: Data mining

- ULX: First host with two PULX
- QPE: First in an optical TDE
- TDE: Several missed in archives

Application #2: Transient alerts

Details in the submitted paper

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Details in the submitted paper

Outlook

New data: eROSITA, LSST, ...

Analyse the results of the **live run**:

Focus on TDEs & QPEs

Starting at ESAC in September

Use the alerts

Data mining: a lot remaining (e.g. stars or XRBs)

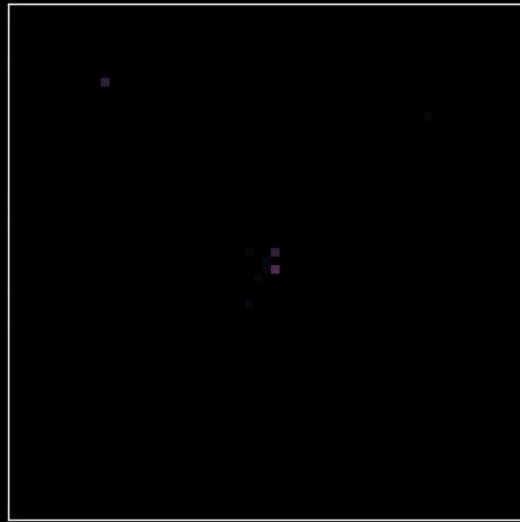
Ideas ? Objects to look for ?
Contact me !

erwan.quintin@irap.omp.eu

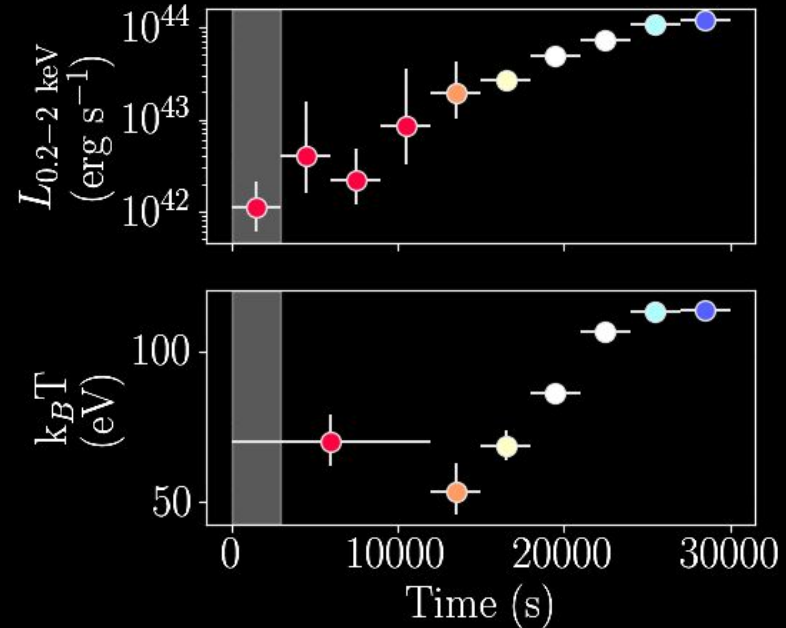


"That's all Folks!"

Tormund's return: QPE features from a recent optical TDE



0.3-0.9 keV EPIC-pn Image



Adapted from Quintin et al. 2023