ATCA radio follow-up observations of eROSITA selected tidal disruption event candidates

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Tidal Disruption Events

When a supermassive black hole destroys a star

Image Credit: DESY, Science Communication Lab

Tidal Disruption Events

When a supermassive black hole destroys a star

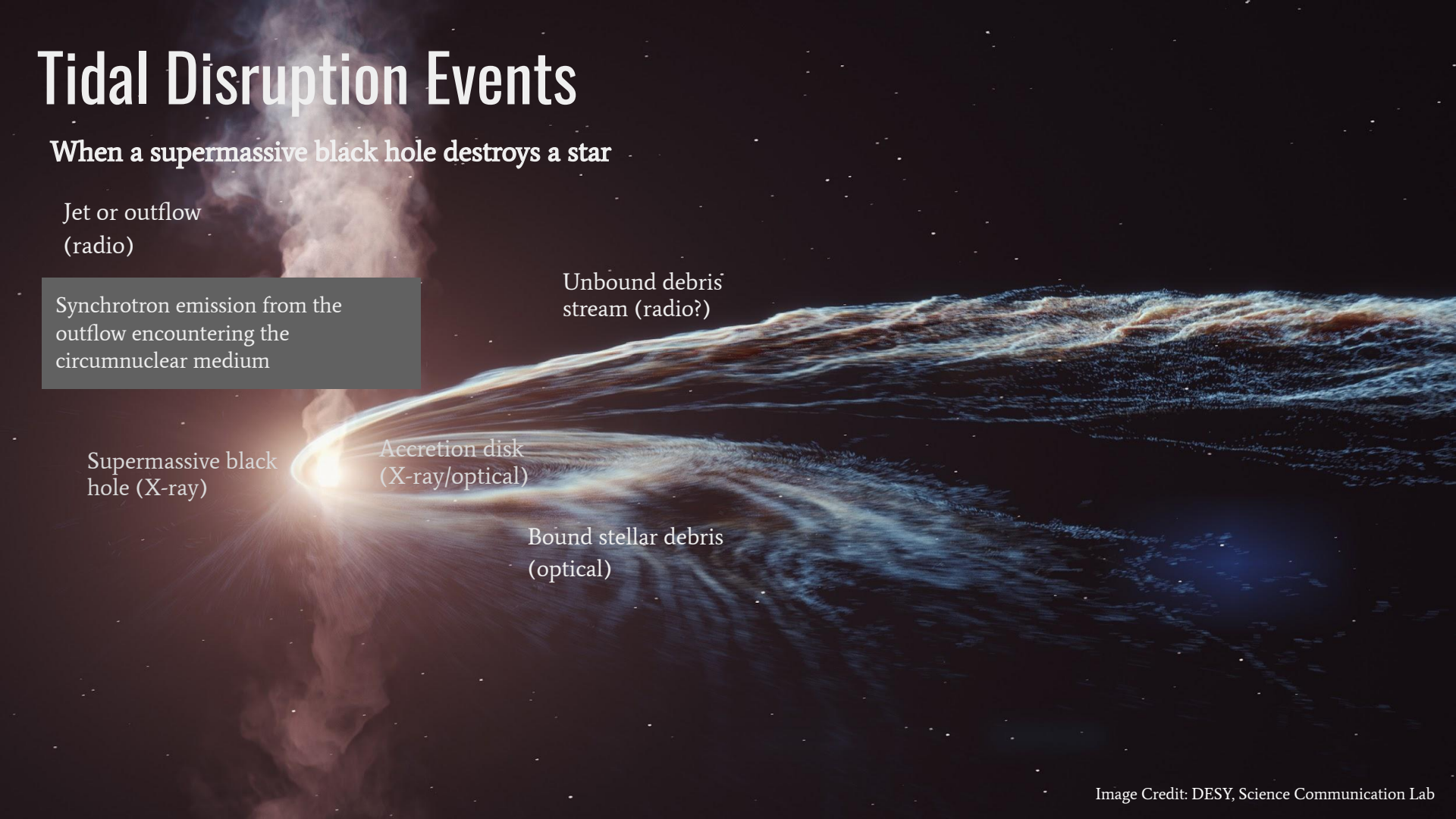
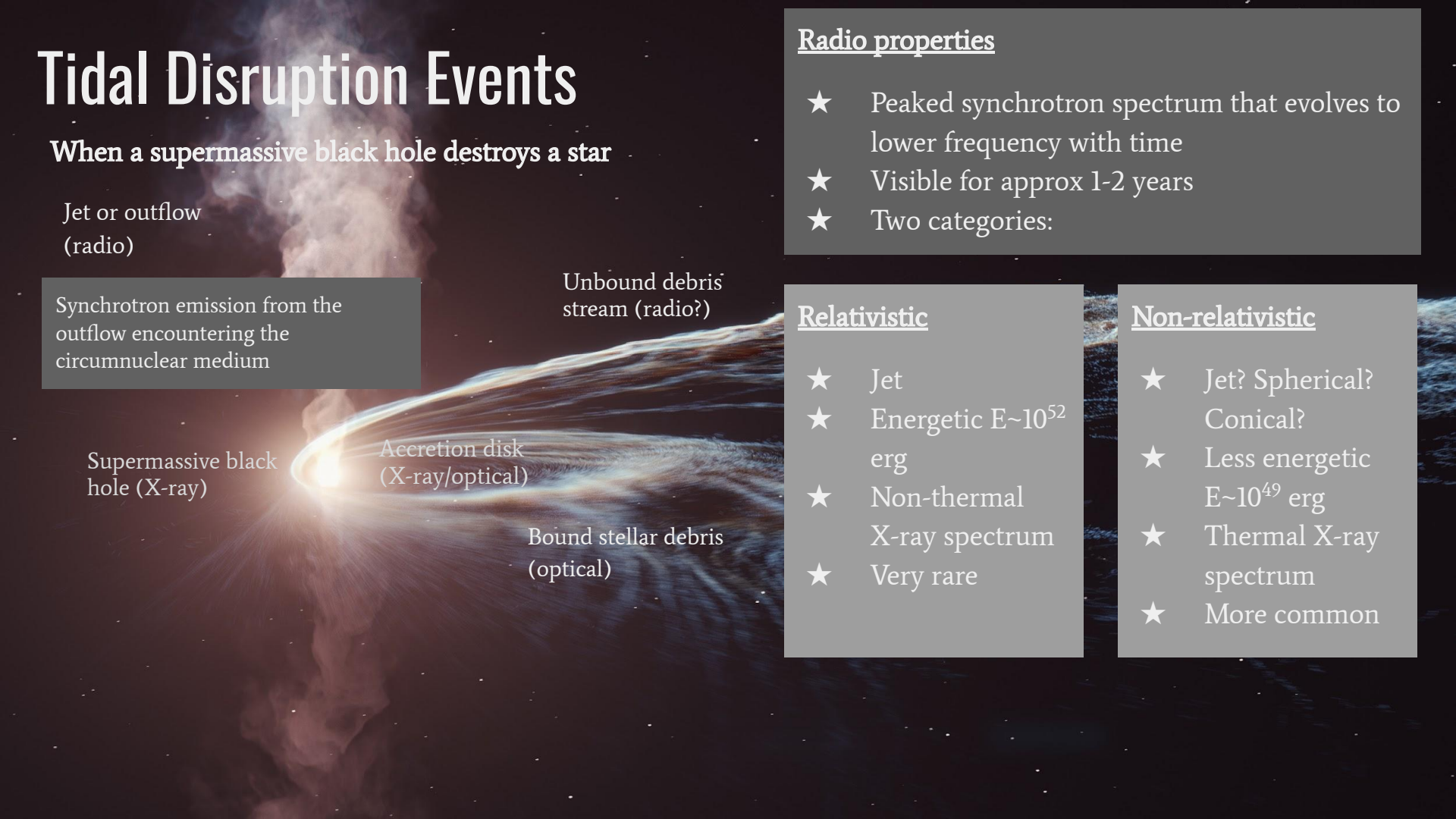


Image Credit: DESY, Science Communication Lab

Tidal Disruption Events

When a supermassive black hole destroys a star



Radio properties

- ★ Peaked synchrotron spectrum that evolves to lower frequency with time
- ★ Visible for approx 1-2 years
- ★ Two categories:

Relativistic

- ★ Jet
- ★ Energetic E~10^{52} erg
- ★ Non-thermal X-ray spectrum
- ★ Very rare

Non-relativistic

- ★ Jet? Spherical? Conical?
- ★ Less energetic E~10^{49} erg
- ★ Thermal X-ray spectrum
- ★ More common

Tidal Disruption Events

When a supermassive black hole destroys a star

Jet or outflow (radio)

Synchrotron emission from t outflow encountering the circumnuclear medium

Supermassive black hole (X-ray)

Unbound debris

Bound stellar debris (optical)

Not all TDEs are detected in the radio. Only ~10% in the literature are published with radio detections.

Open questions:

- What produces the radio emission in TDEs?
- What is the prevalence of radio emission from X-ray selected TDEs?

Radio properties

- ★ Peaked synchrotron spectrum that evolves to lower frequency with time
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- ★ Two categories:

X-ray spectrum

★ Very rare

on-relativistic

Jet? Spherical? Conical?

Less energetic $E \sim 10^{49}$ erg

★ Thermal X-ray spectrum

★ More common

ATCA radio follow-up of eROSITA TDEs summary

- Two programs:
  - Early time: we have triggered on 9 TDEs and detected 6 TDEs
  - Late time: we have 26 in the sample, have observed 11 so far, with the remaining 15 scheduled to be observed next week.
    - Of the 11, we detected 5 in the radio

The best eROSITA TDE candidates

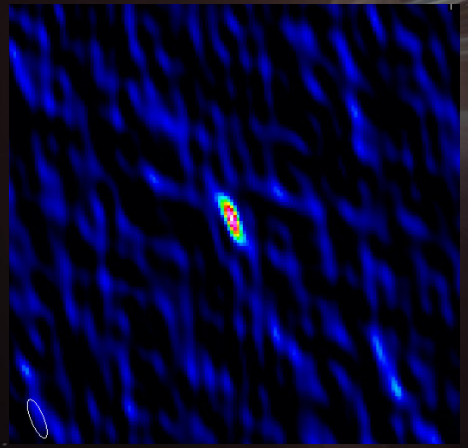
Object	Dates observed	Detection?
eRASSt_J045650-203751	8 times over 2021-2023	Transient detections (Liu+2023, Liu+2024) A repeating partial TDE
eRASSt_J181035-812024	October 2, November 17, upcoming March 2024	Detection at 2.1 GHz, not transient; non-detection at 5 and 9 GHz
eRASSt_J062524-411100	November 15 2021, February 1 2021	No detection
eRASSt_J234403-352640	12 epochs between April 2021-March 2024	Detected at all frequencies (2-21 GHz), evolving between observations (Goodwin+2024)
eRASSt_J164650-692540	August 2022, November 2022	Yes, not variable
eRASSt_J034518-321910	March 2022, April 2022	Marginal initial detection, not detected again
eRASSt_J154222-224013 (AT222dsb)	7 epochs between March 2023-2024	Detected at all frequencies (2-21 GHz), evolving between observations (Malyali+2023, Goodwin+in prep)
eRASSt_J043546-531927	March 2022	Not detected
eRASSt_J133158-324322	March 2022	Not detected (Malyali+2022)

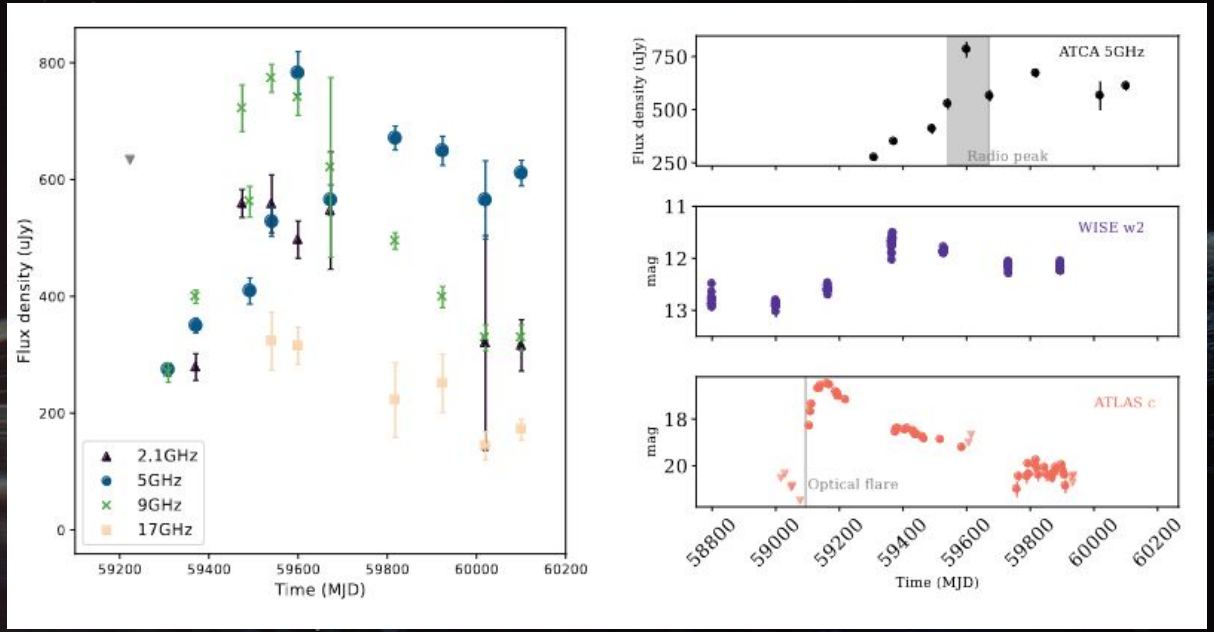
eRASSt_J234403-352640 Radio Lightcurve

Goodwin+2024, MNRAS, 528, 4

ATCA observations:

12 epochs over ~3 year spanning 2-21 GHz





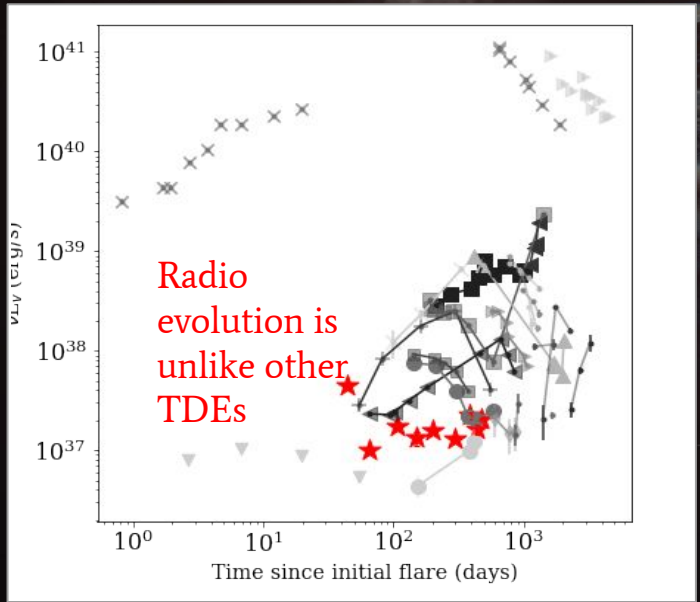
Lightcurves of J2344

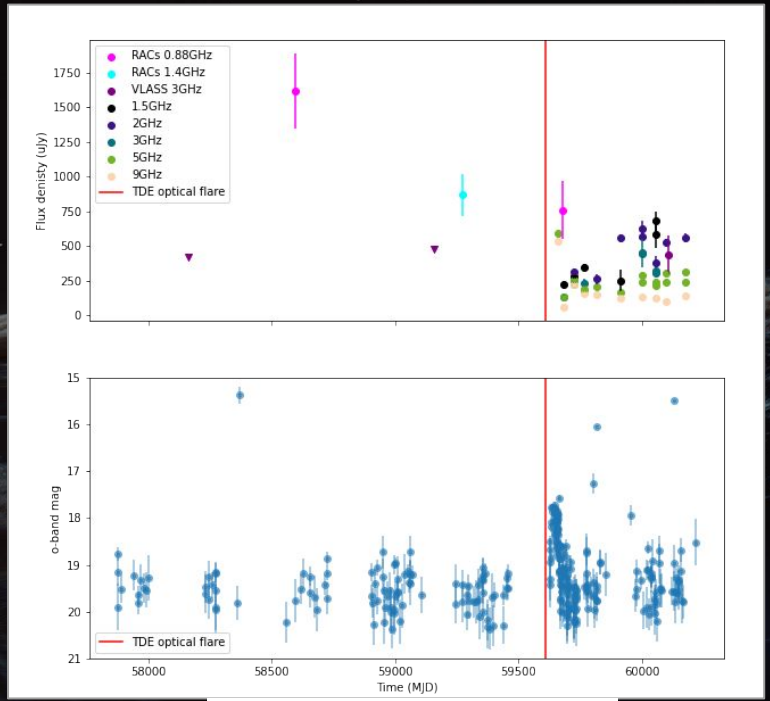
AT2022dsb Radio: an AGN shrouded by a Tidal Disruption Event?

Malyali+2023, Goodwin+in prep

ATCA observations:

7 epochs over ~2 year spanning
2-21 GHz



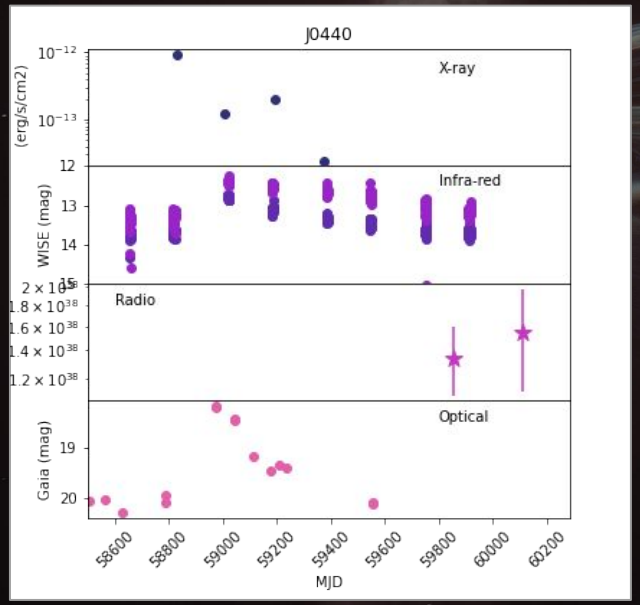


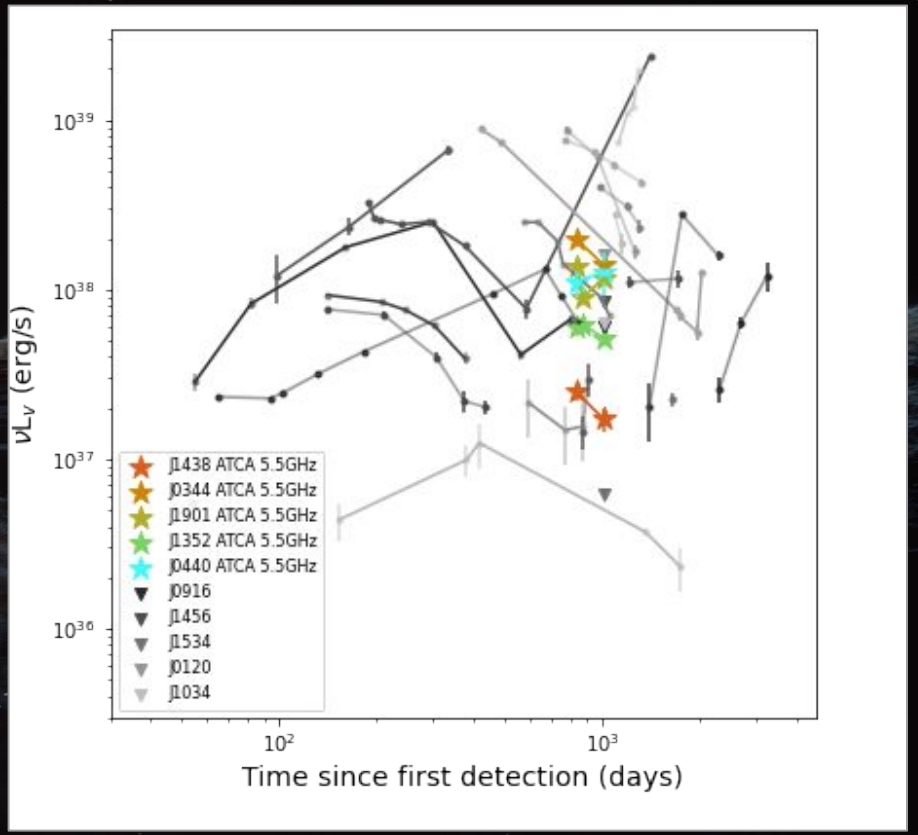
Lightcurves of AT2022dsb

Late time TDE observations

- 11 observed
  - 7 detected
  - 5 likely transient
- 4 radio-detected with flares at IR or optical as well

Multiwavelength light curve of J0440





Summary of radio detections of eROSTIA TDE sample of 11

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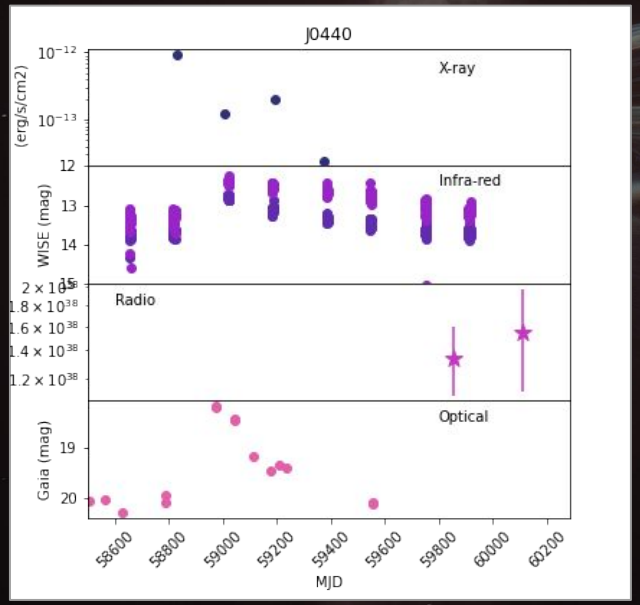
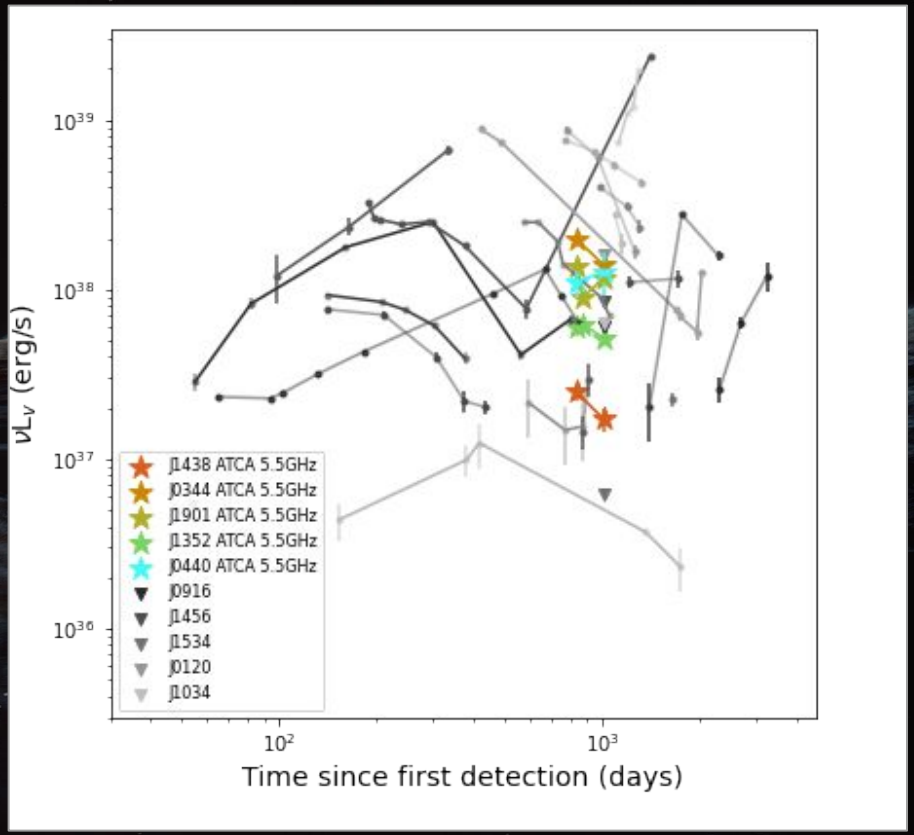
Multiwavelength light curve of J0440



★ Another 15 TDE candidates to be observed next week



Summary of radio detections of eROSTIA TDE sample of 11

Summary

- ★ We have triggered ATCA radio follow-up observations of 20 eROSITA TDE candidates.
  - 9 non-detections, 3 non-transient detection, and 8 transient radio afterglows discovered
- ★ J2344 is the best eROSITA radio outflow TDE candidate evolving in the radio on timescales of months, with radio properties similar to other thermal TDEs
- ★ AT2022dsb appears to be an AGN in which a TDE occurred
- ★ These observations help us learn about accretion onto supermassive black holes, the circumnuclear environment, and how jets and outflows may be launched