

Polarization variability in Tidal Disruption Events



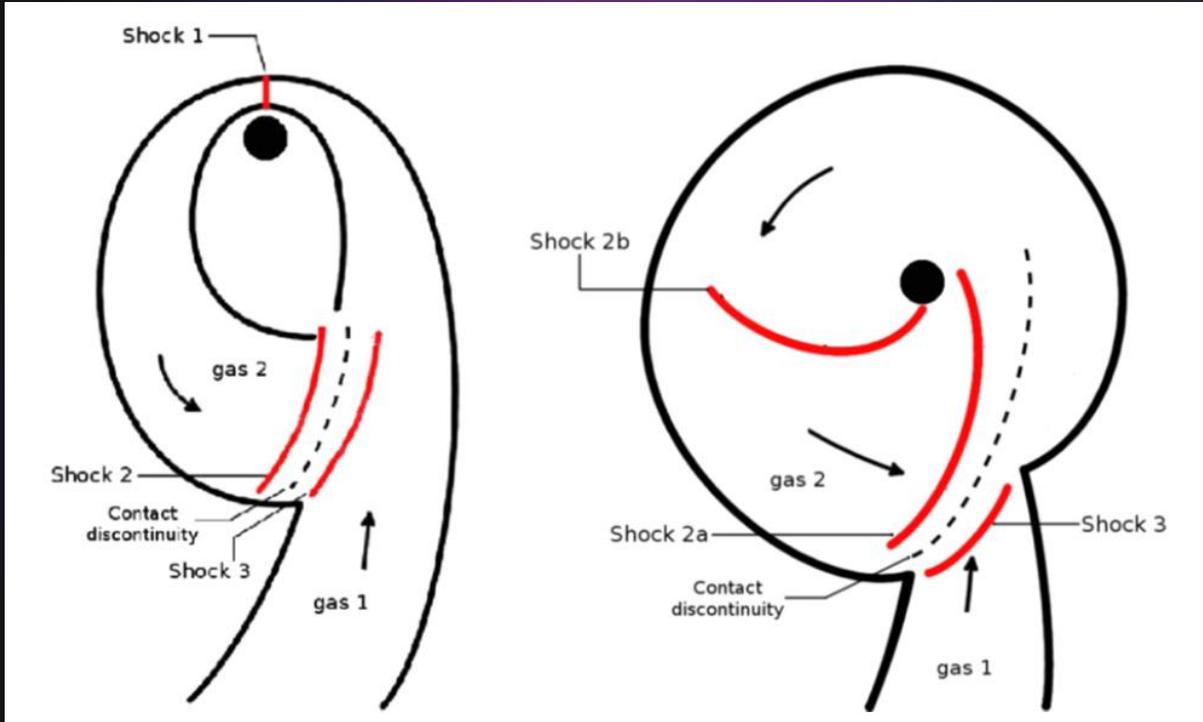
Alberto Floris

BOOTES

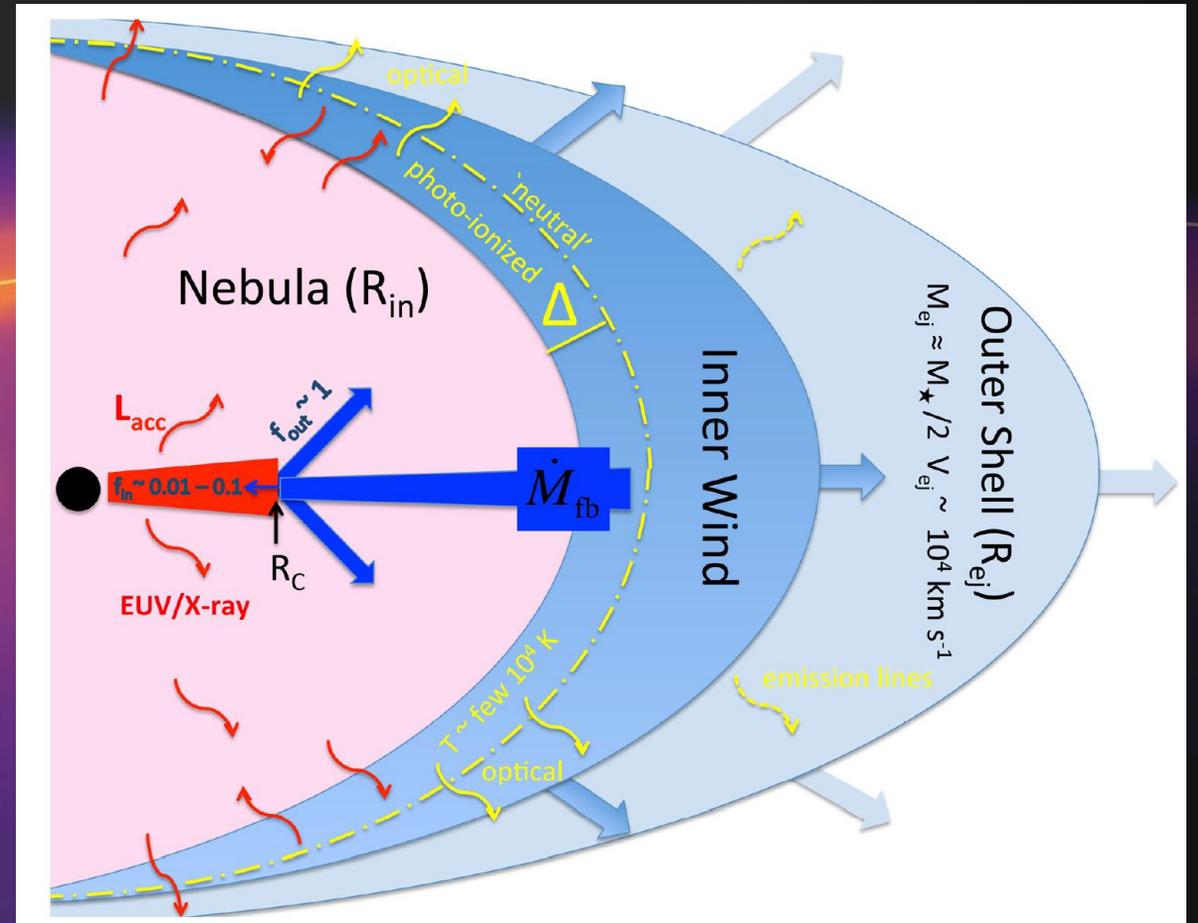
Black hOle Optical polarization TimE domain Survey



Shock and reprocessing models



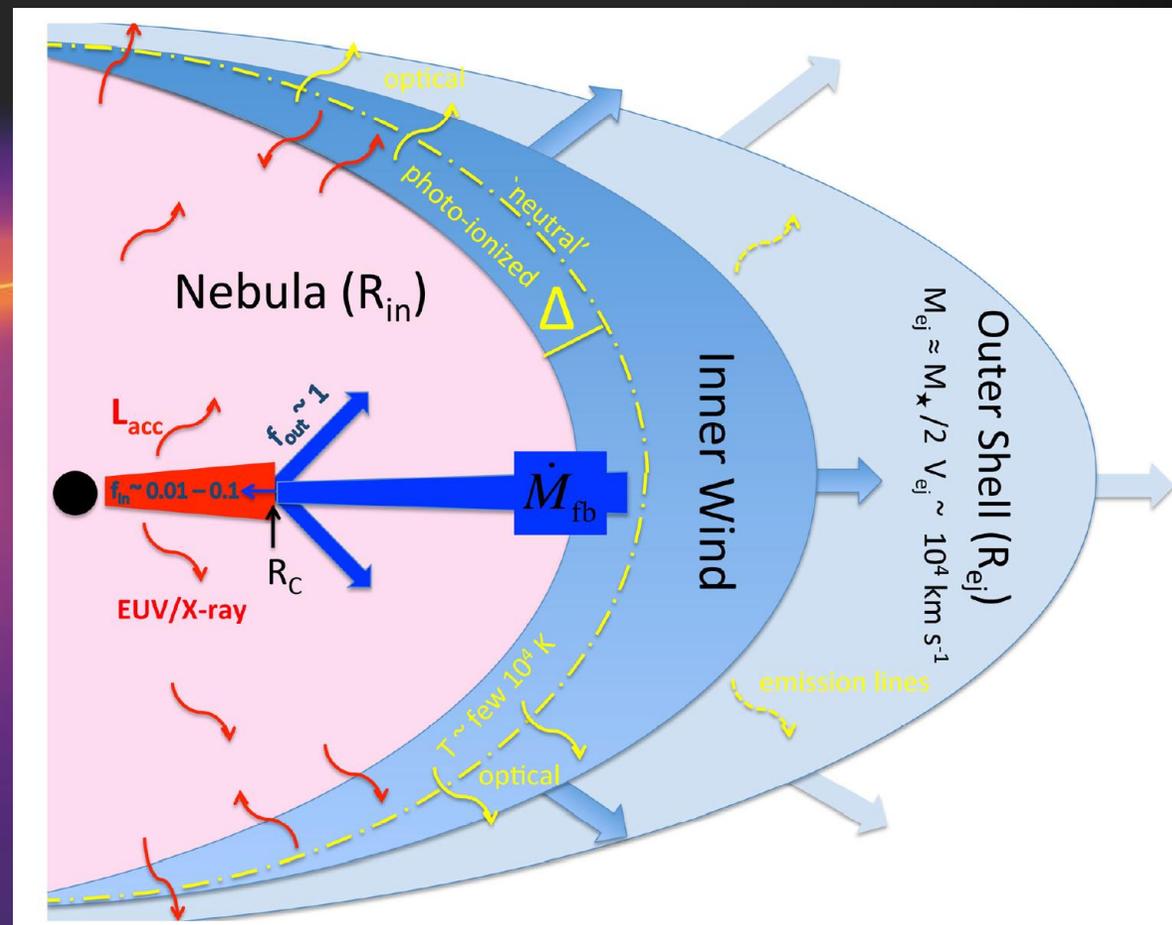
Piran et al. (2015)



Metzger & Stone (2016)

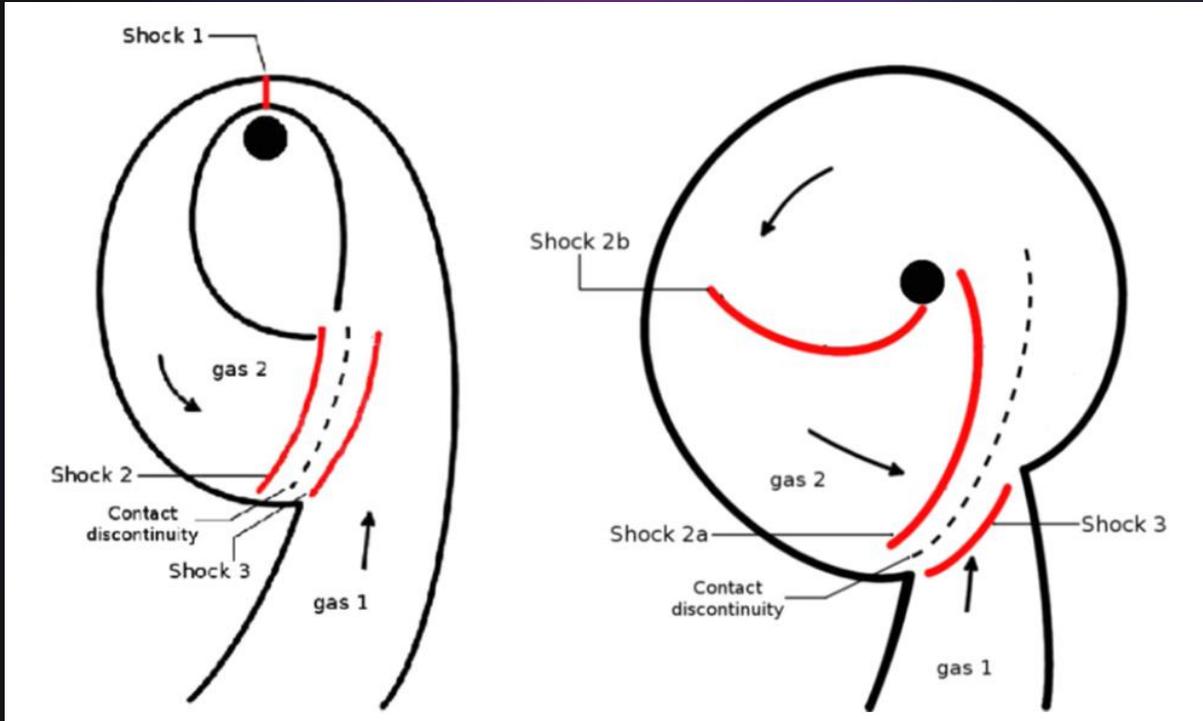
Reprocessing model

- Formation of an accretion disk producing EUV/X-ray photons
- Reprocessing from an optically thick gas/dust layer into optical/IR photons
- “Coronal” lines (?)
- Late-time X-rays (?)
- Polarization degree < 6%
- Constant polarization over short timescales



Metzger & Stone (2016)

Shock model



Piran et al. (2015)

- Multiple shocks produced by collision between disrupted stellar streams
- Accretion disk formed more slowly
- More complex, likely with multiple emission regions
- Late-time X-rays (?)
- No hard cap on polarization degree, possibly high
- Polarization variability

BOOTES

Black hOle Optical polarization Time-domain Survey (BOOTES) aims to monitor TDEs to track changes in polarization

Telescopes:

- Skinakas 1.3m
- OSN T90
- NOT
- Calar Alto 2.2m
- VLT

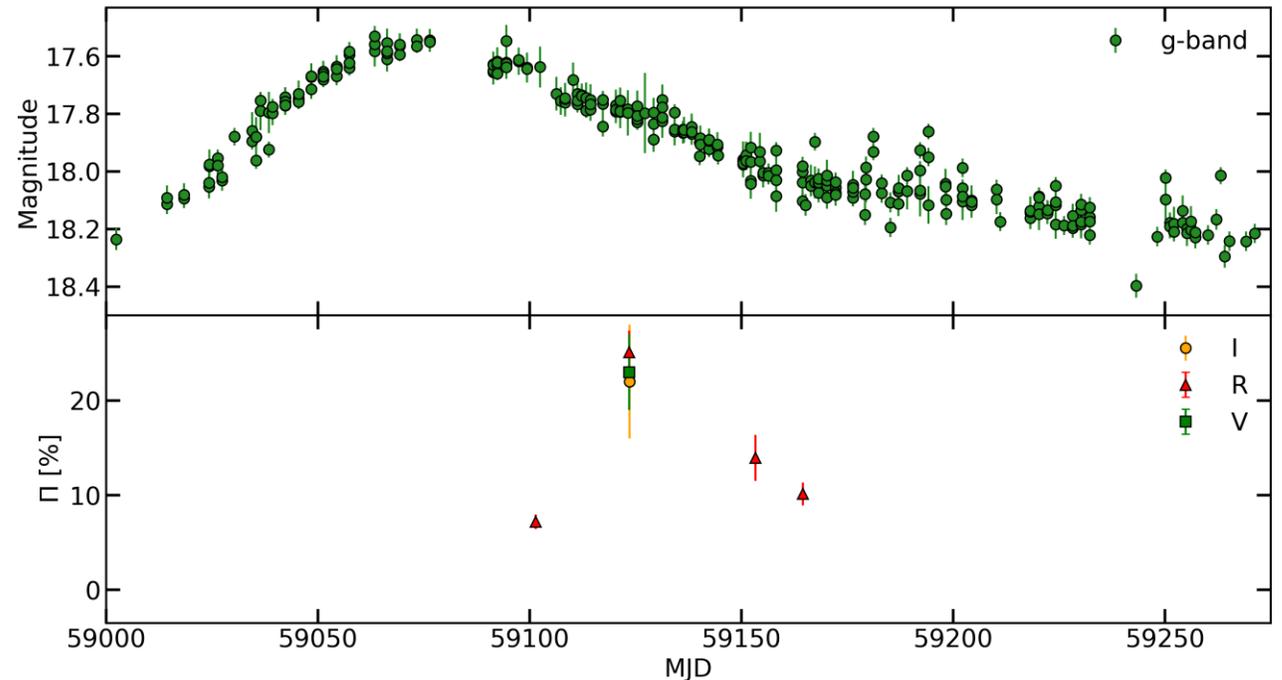


The anomaly of AT2020mot

Initial measurements of TDE polarization:

- Jetted: Wiersema+12,16, Cikota+23
- UV-optical: Higgins+19, Lee+20, Leloudas+22, Patra+22, Koljonen+24, Koljonen+25, etc.

AT2020mot exhibited extraordinary and variable Π ($\sim 25\%$), alongside typical optical TDE properties (Liodakis+23)

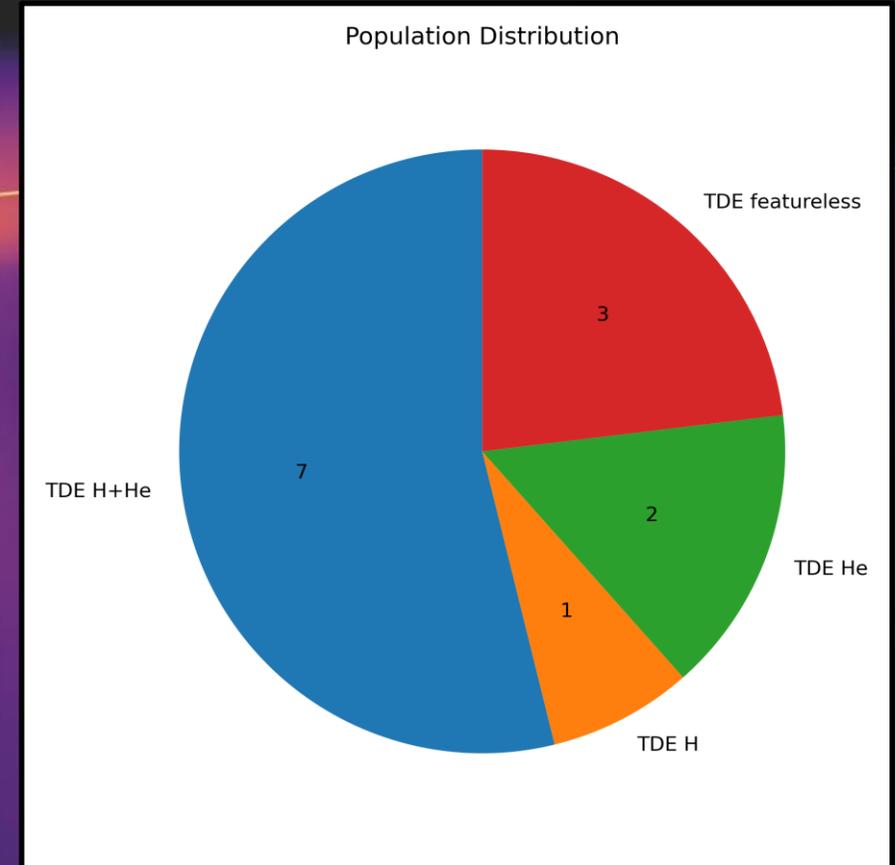


Sample

Sample:

- 13 classified TDEs
- Polarimetric observations from BOOTES campaign
- Optical photometry from Zwicky Transient Facility (ZTF) survey
- UV photometry from Swift-UVOT
- X-ray observations with XMM-Newton and Swift-XRT

Modelling lightcurve using **MOSFiT** and **TDEMass** codes

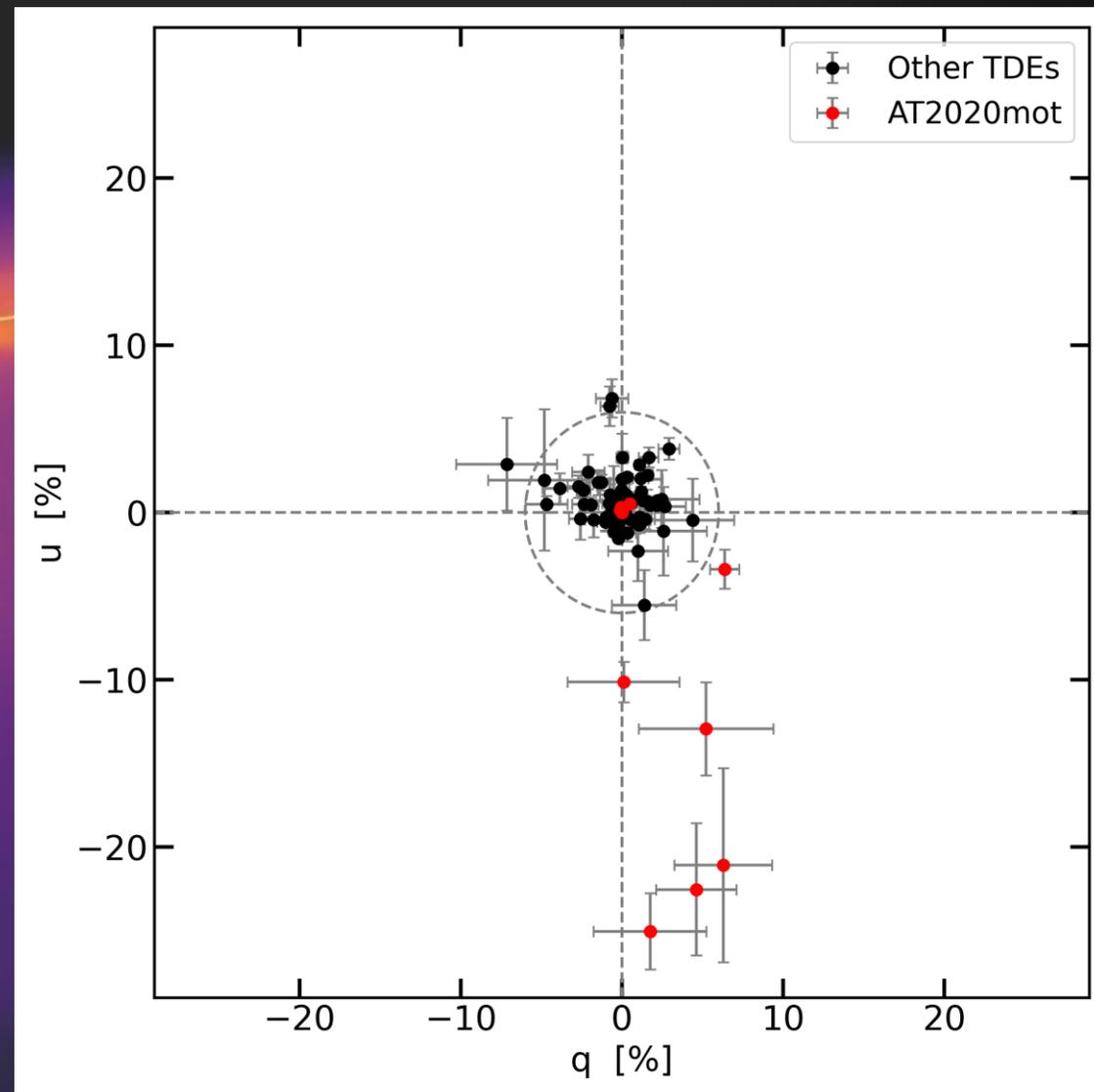


Polarization of the sources

Low polarization is observed in the majority of the sources

AT2020mot appears as the exception

The intrinsic polarization of the host galaxy affects measurements (Andruchow+2008)



Population study results

- AT2020mot consistent with the rest of the sample on most parameters
- Outlier for Π and N_{H} of the host

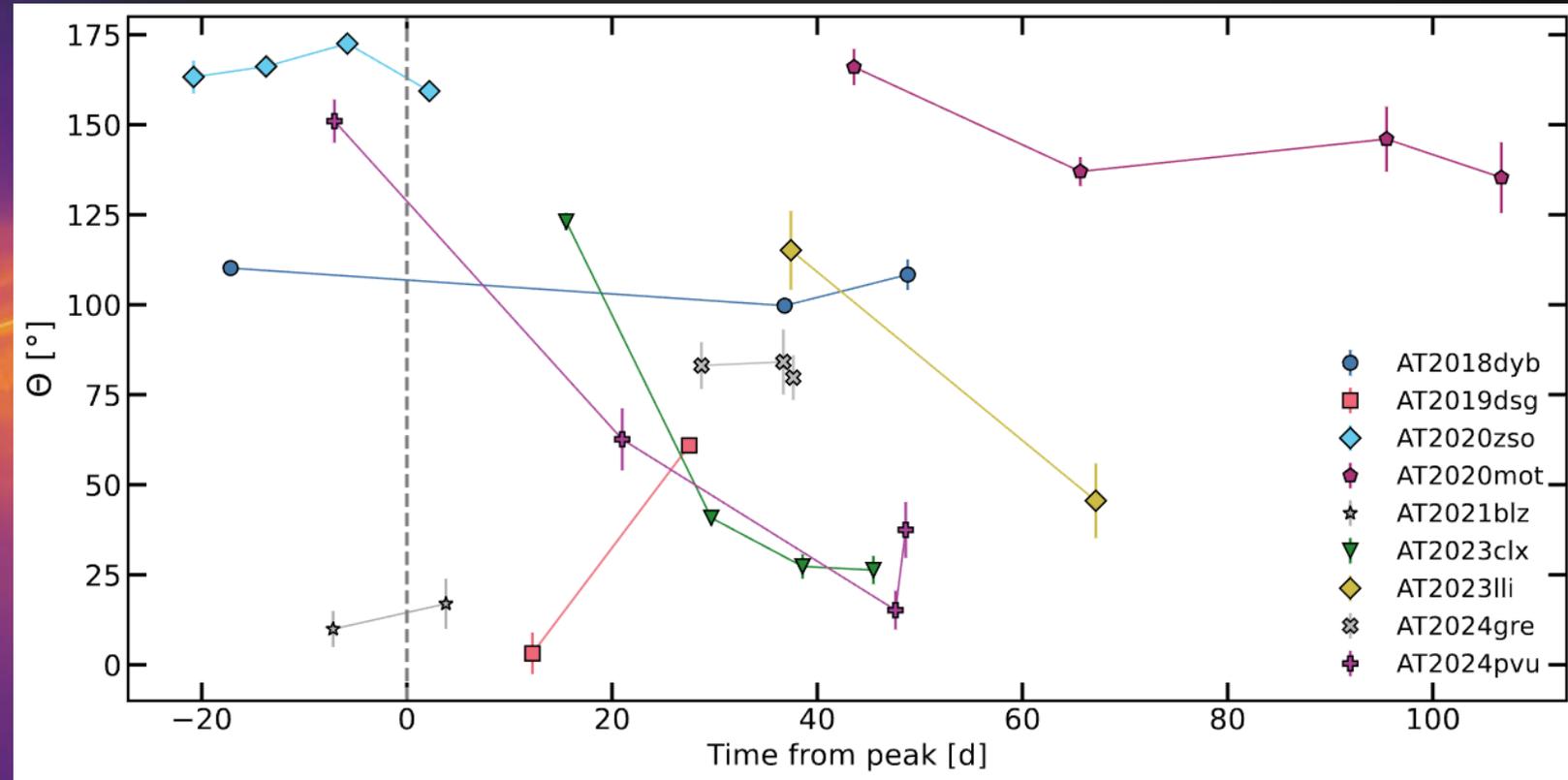
Parameter	Median	σ	AT2020mot	Agreement
(1)	(2)	(3)	(4)	(5)
T [K]	29600	12100	31700	✓
$\log L_{\text{bol}}$ [erg s ⁻¹]	43.77	0.61	44.10	✓
$\log L_{\text{X}}$ [erg s ⁻¹]	42.45	0.69	<42.69	✓
t_{rise} [d]	56.4	40.9	71.5	✓
z	0.049	0.036	0.07	✓
Π_{max} [%]	4.1	2.3	25	X
$\log M_{\text{BH,TDEMass}}$ [M_{\odot}]	6.18	0.52	6.45	✓
$M_{\text{star,TDEMass}}$ [M_{\odot}]	0.67	0.62	0.97	✓
$\log M_{\text{BH,MOSFiT}}$ [M_{\odot}]	6.66	0.76	7.26	✓
$M_{\text{star,MOSFiT}}$ [M_{\odot}]	0.57	5.11	0.63	✓
b	0.96	0.39	0.91	✓
$\log N_{\text{H}}$ [cm ⁻²]	18.29	1.14	20.80	X

Polarization angle variability

We studied all available polarimetric detections of TDEs from the literature and BOOTES

We find:

- Significant variability of the polarization angle
- Some sources exhibit steady changes of >90 degrees
- Most sources in the sample show overall variability



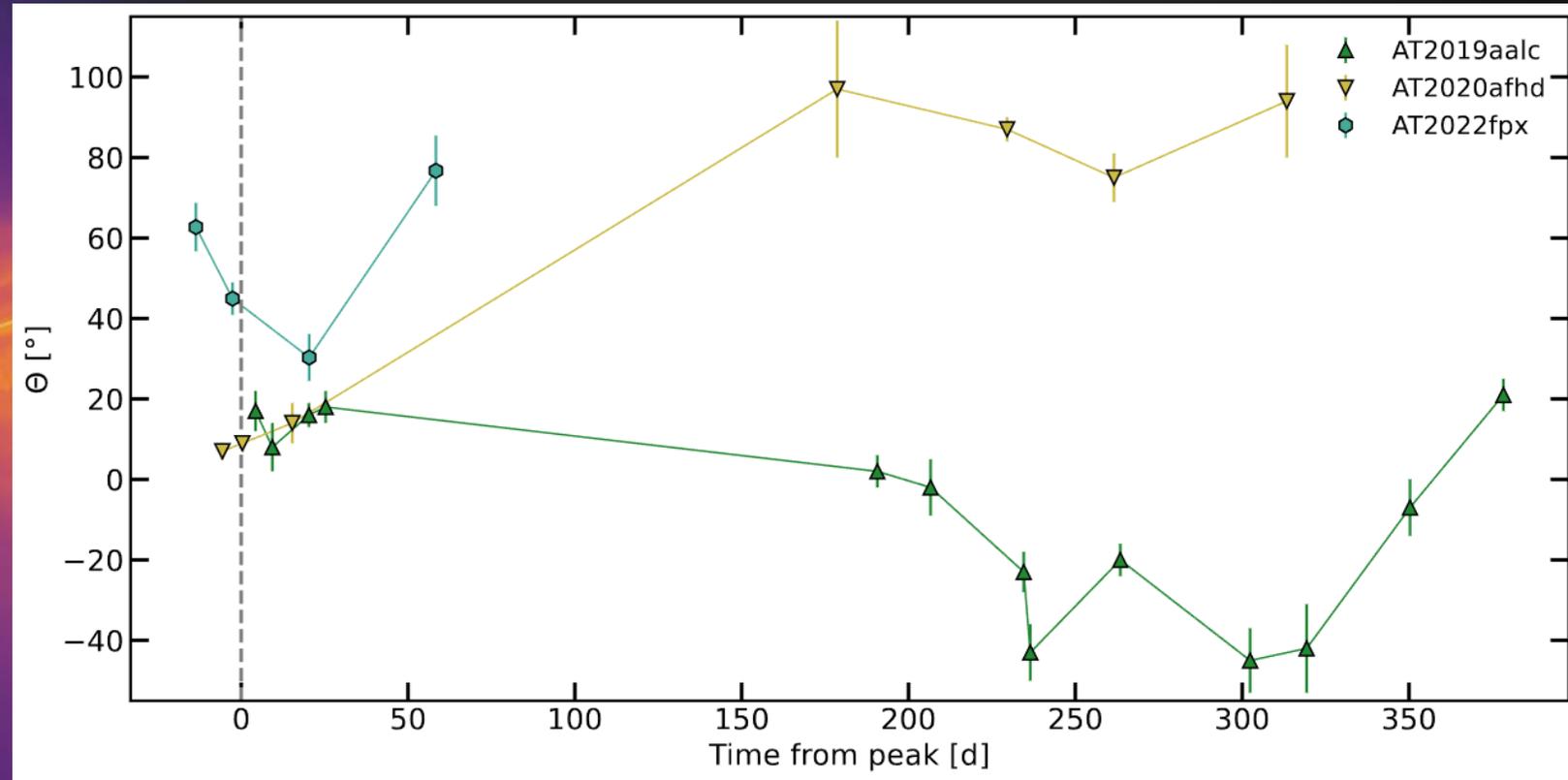
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Bowen Fluorescence Flares show different behavior from TDEs

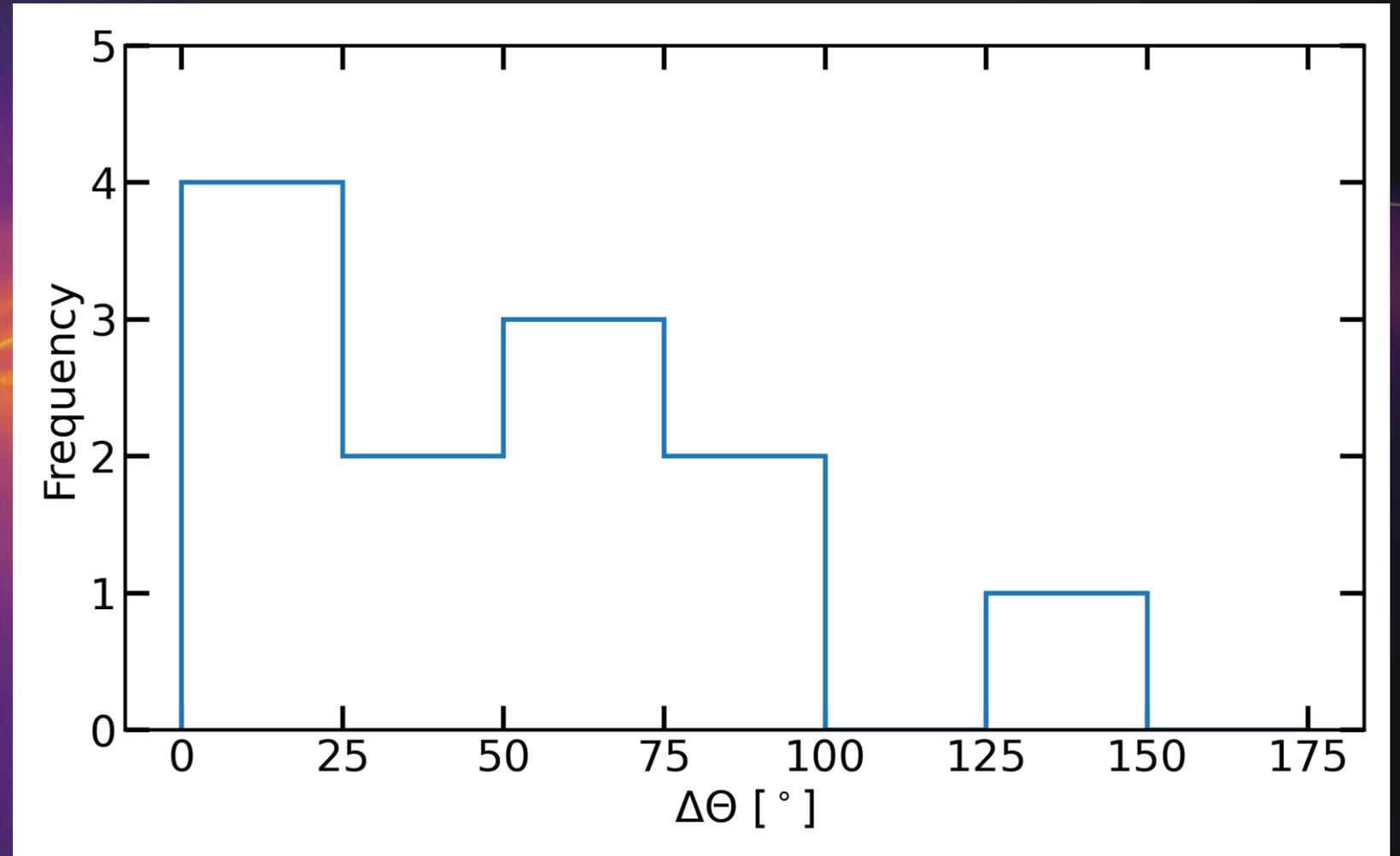


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AT2024tvd



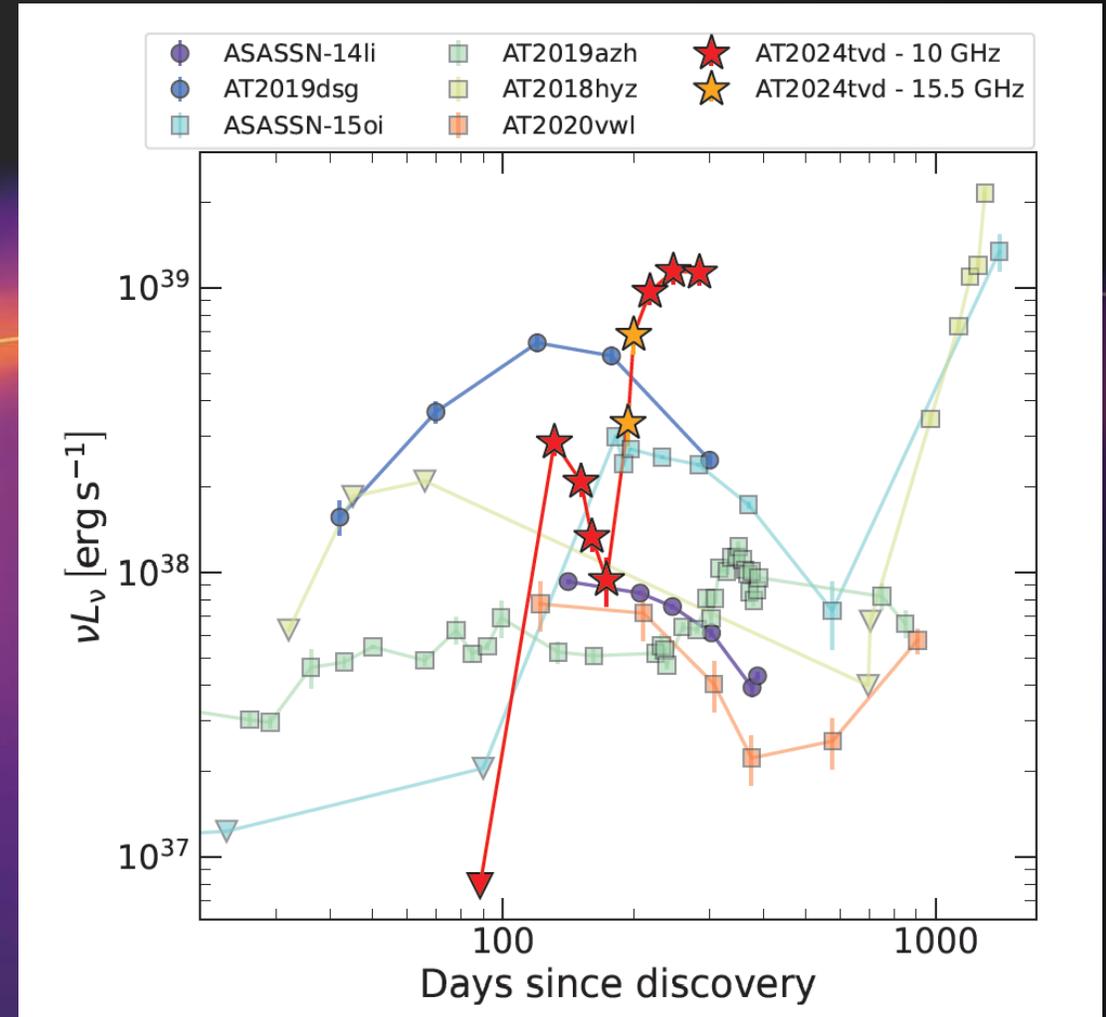
AT2024tvd

The first TDE not occurring in the galaxy nucleus

Exhibits otherwise typical optical TDE spectrum and light curve.

Delayed Radio emission and detected X-rays

Optical polarization in the B,V,R bands: $<0.5\%$



Sfaradi et al. 2025

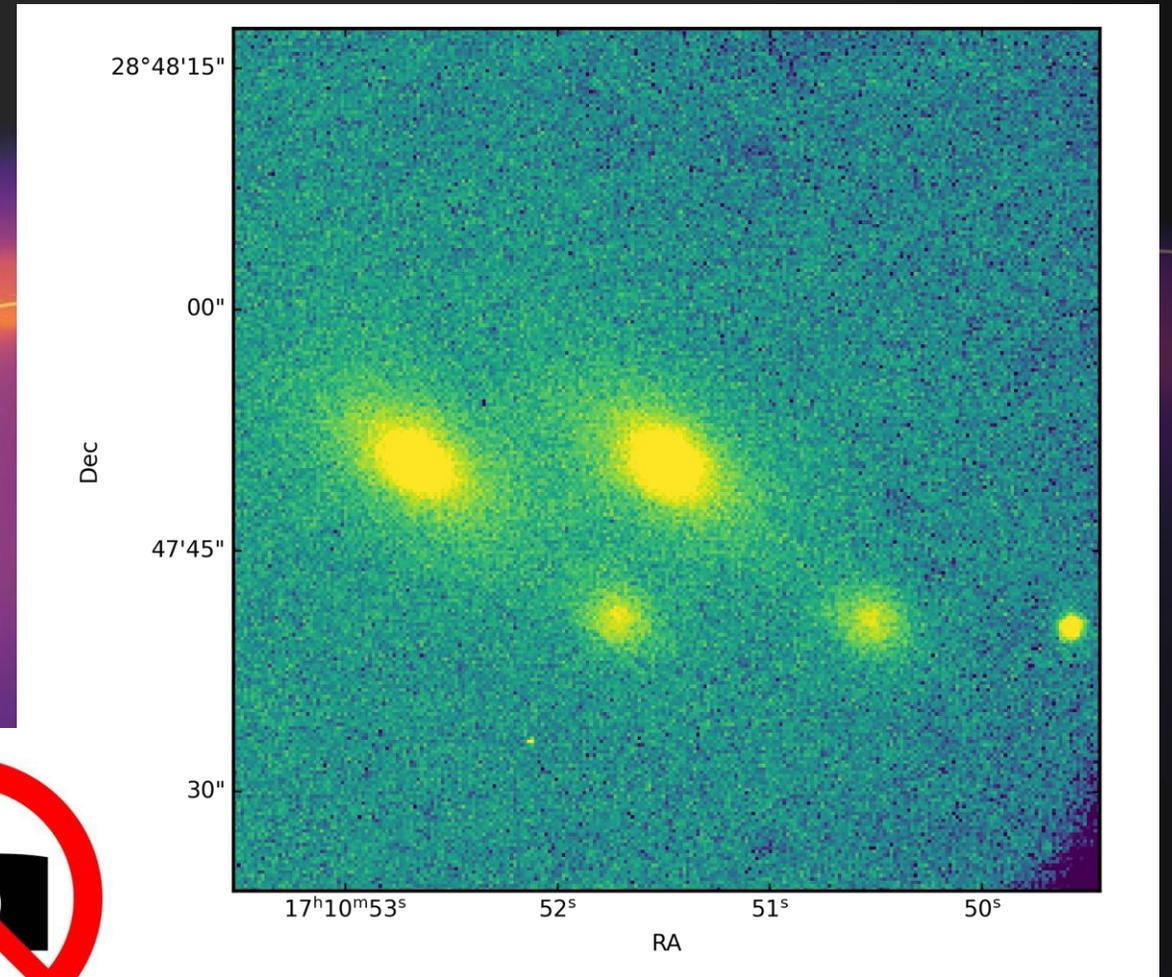
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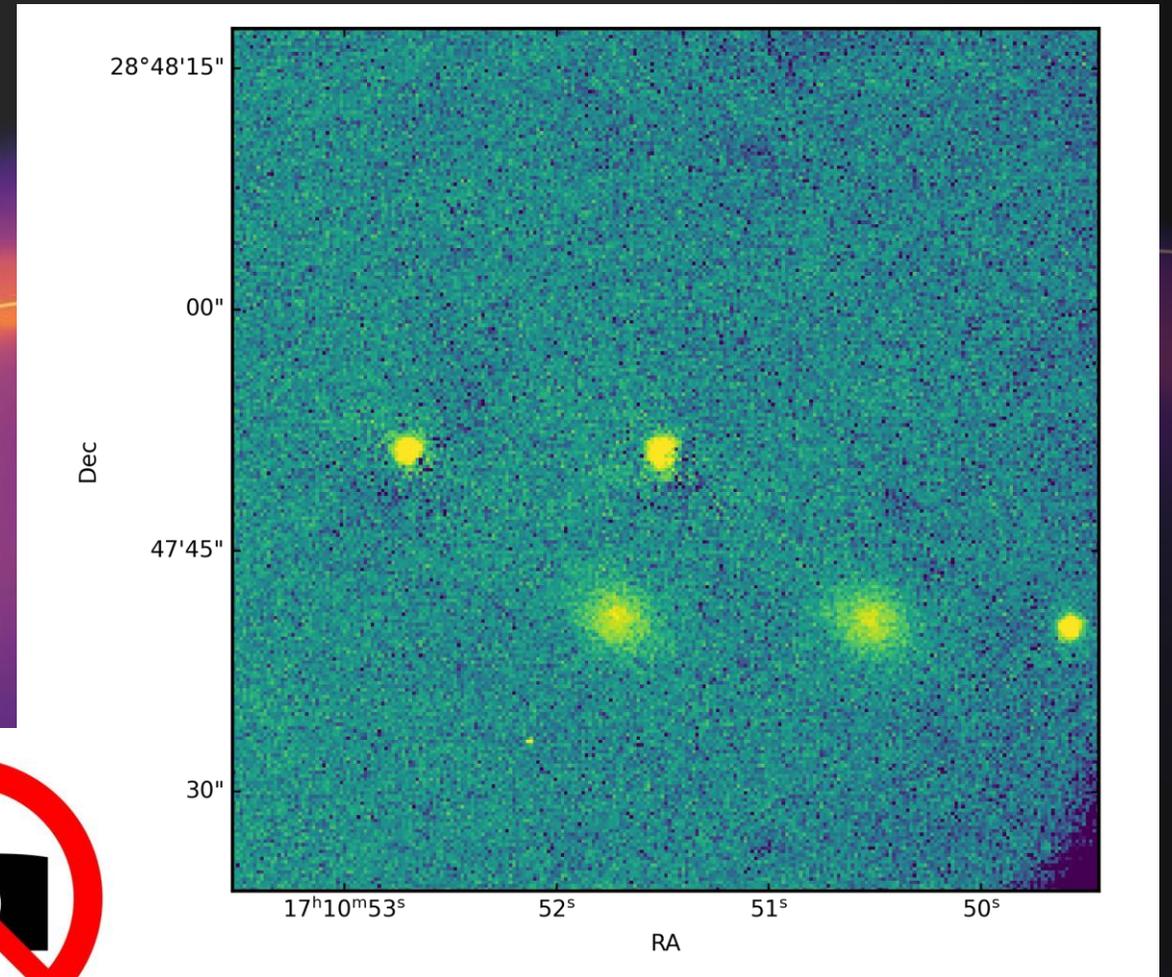
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We subtracted the host-galaxy \rightarrow POLARIZED

Strong evidence for jet formation



Conclusions

- Polarimetric measurements can help solve the question of what powers TDEs
- TDEs are likely intrinsically polarized
- TDE polarization appears variable both in angle and degree
- Denser polarimetric monitoring, contemporaneous spectroscopy and X-ray/UV coverage are needed to discriminate among models, providing testable signatures
- Exciting times ahead: LSST and wide-field polarimeters will help shed light on these questions providing larger samples and more polarimetric measurements