Finding Tidal Disruption Events with ZTF

An AMPEL case study

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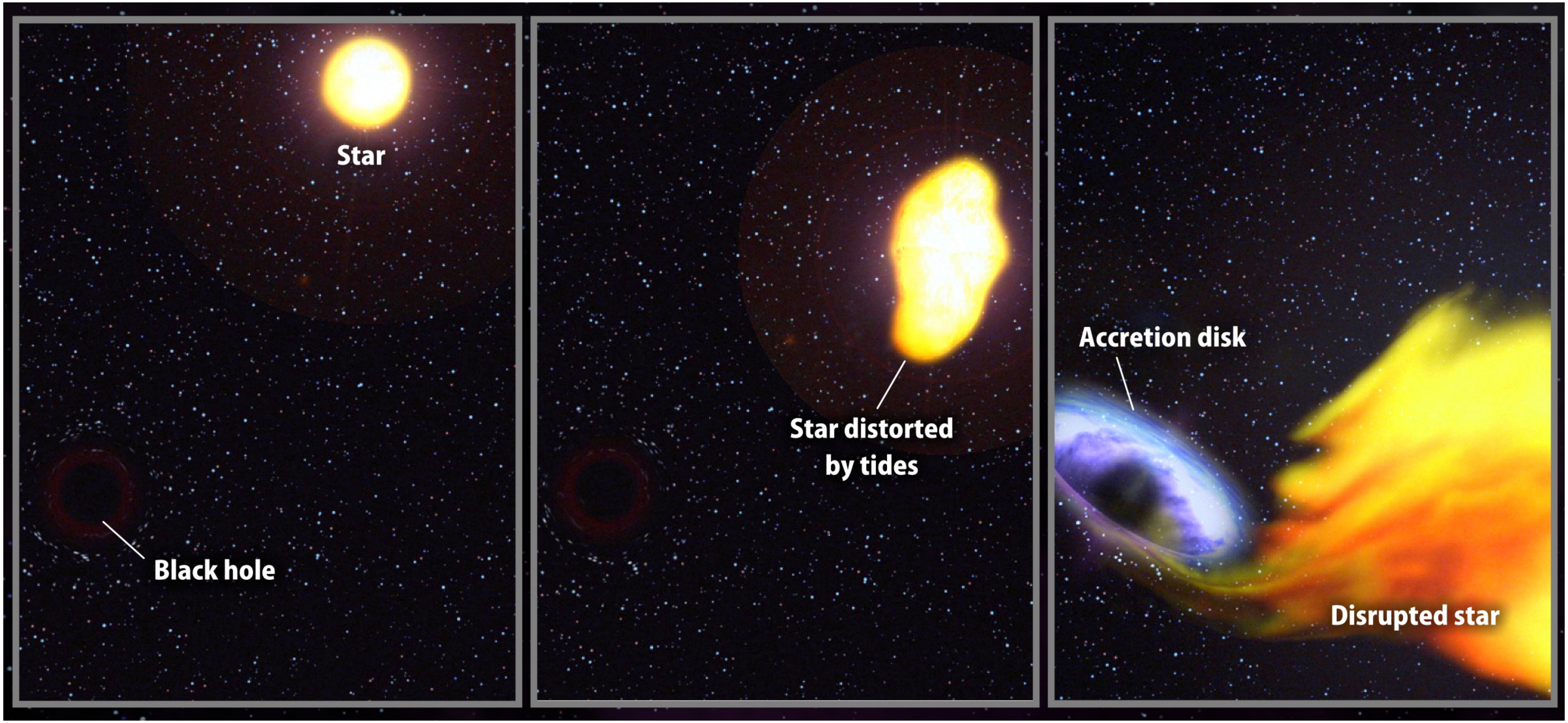
ZWICKY TRANSIENT FACILITY

DESY

What are Tidal Disruption Events?



1

2

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The state of play in March 2018

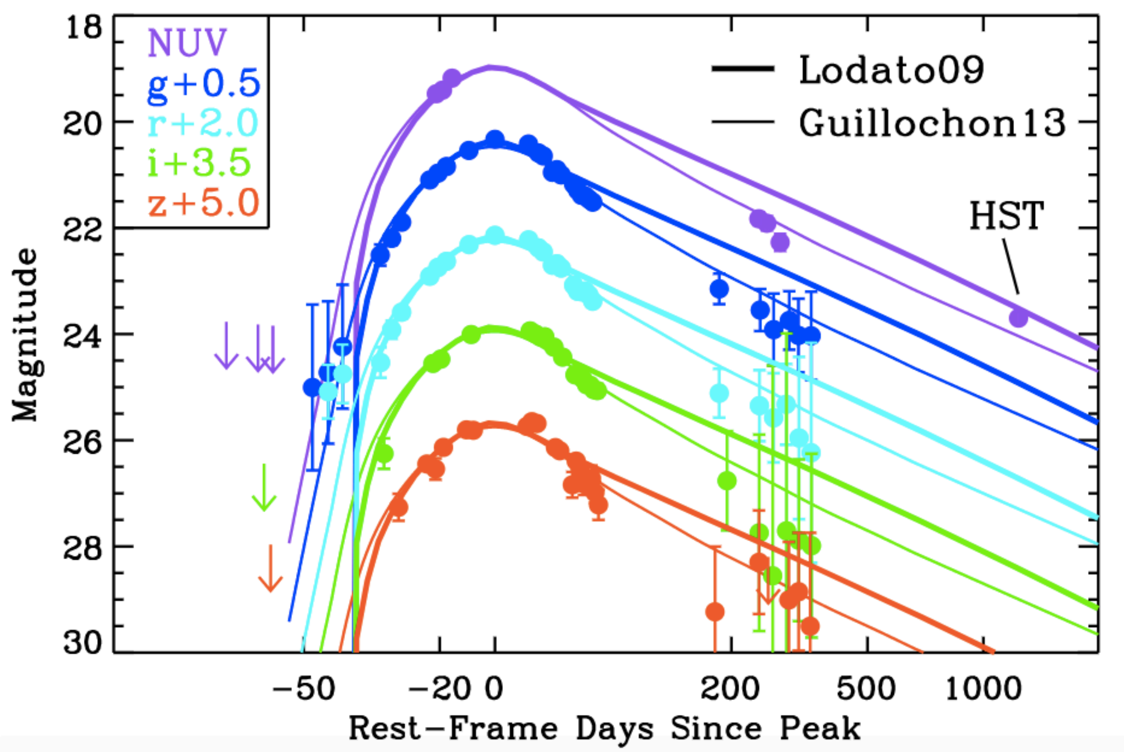
Proposed at the end of the 1980s, TDEs have historically proved difficult to find

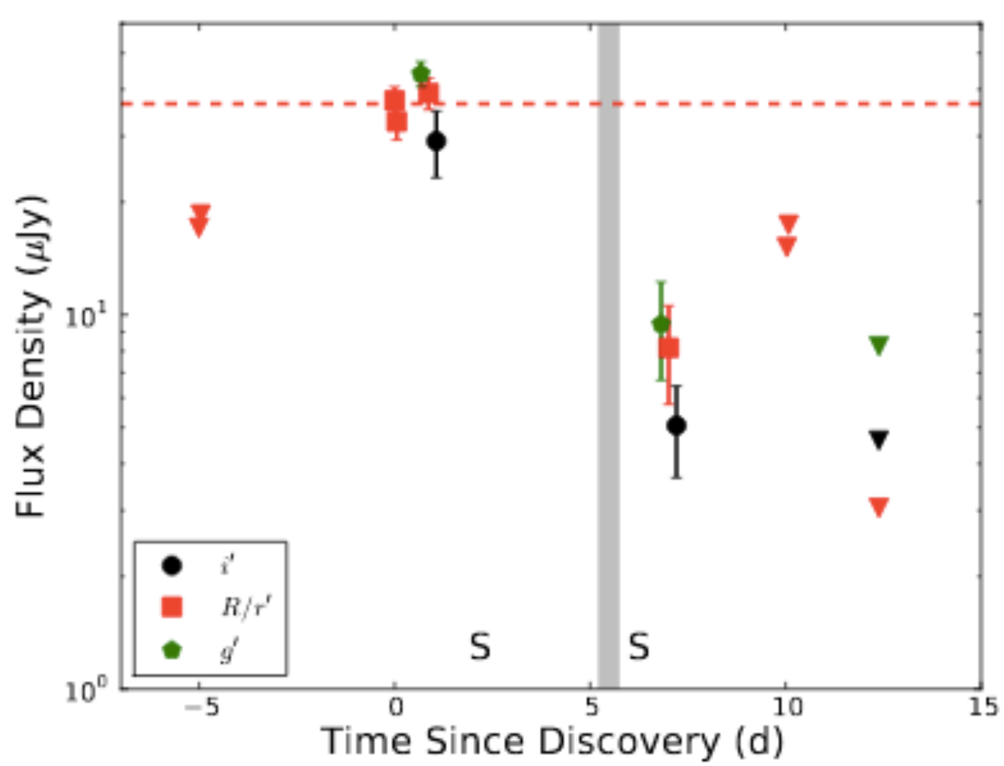
~70 “TDE candidates” in the literature

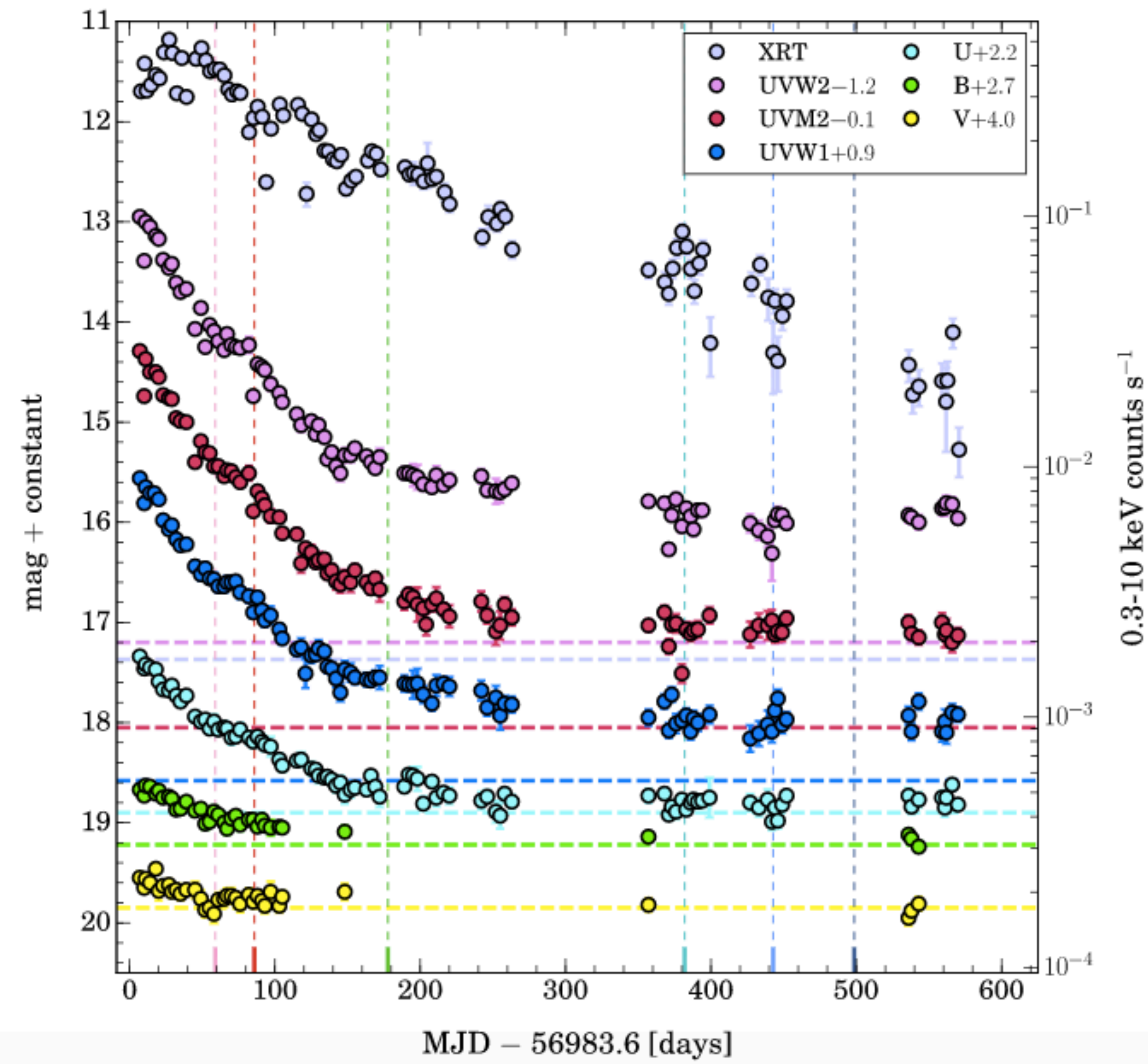
~ 12 have “clean” classifications

Only 4 have well-sampled rising light curves

The Good, the Bad and the Ugly…







Quick identification is key for obtaining timely spectra!

How can we find TDEs?

Start with full ZTF stream

Apply quality cuts, and identify small host offsets

Remove stars through crossmatch to PanStarrs+GAIA catalogues

Identify likely AGN through WISE colours

Light curve fits, giving shape/colour, help identify likely SNe

SEDm spectroscopic follow-up to identify TDEs

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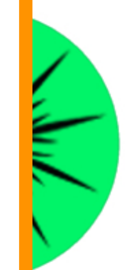
In future?

How can we find TDEs?

Start with full ZTF stream

A

AMPEL is vital for handling ZTF alert volumes



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In future?

Some statistics

~100M Alerts

AMPEL: Quality and offset cuts + Lightcurve fits

~3000 added for automated “ranking”

Humans: Select candidates for follow-up

~300 for SEDm

Spectroscopic identification of TDEs

The first results are now published…

The first tidal disruption flare in ZTF:
from photometric selection to multi-wavelength characterization

Sjoert van Velzen,[1,2] Suvi Gezari,[3,4] S. Bradley Cenko,[5,4] Erin Kara,[3,6,4] James C. A. Miller-Jones,[7] Tiara Hung,[3] Joe Bright,[8] Nathaniel Roth,[3,4] Nadejda Blagorodnova,[9] Daniela Huppenkothen,[10] Lin Yan,[11] Eran Ofek,[12] Jesper Sollerman,[13] Sara Frederick,[3] Charlotte Ward,[3] Matthew J. Graham,[9] Rob Fender,[8] Mansi M. Kasliwal,[9] Chris Canella,[9] Robert Stein,[14] Matteo Giomi,[15] Valery Brinnel,[15] Jakob van Santen,[14] Jakob Nordin,[15] Eric C. Bellm,[10] Richard Dekany,[16] Christoffer Fremling,[9] V. Zach Golkhou,[10,17] Thomas Kupfer,[18,19,9] Shrinivas R. Kulkarni,[9] Russ R. Laher,[20] Ashish Mahabal,[9,21] Frank J. Masci,[22] Adam A. Miller,[23,24] James D. Neill,[9] Reed Riddle,[16] Mickael Rigault,[25] Ben Rusholme,[22] Maayane T. Soumagnac,[26] and Yutaro Tachibana (優太朗橘)[27,28]

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2.2. *Brief history of AT2018zr*

On 2018 March 6, the source ZTF18aabtxvd[1] was identified as a nuclear transient by our alert pipeline. Spectroscopic follow-up observations using SEDM (Blagorodnova et al. 2018) were obtained 3 days later; we measured a blue continuum without significant absorption or emission; a redshift $z = 0.071$ and TDE classification was established using additional spectroscopic observations (Hung et al. 2018, in prep). Upon further investigation we noticed the reference frame was contaminated with light from the transient, which prohibited an earlier detection; after rebuilding the reference images and applying an image subtraction algorithm (Zackay et al. 2016) that is similar to the one used in the IPAC pipeline, we found the first ZTF detection was on 2018 February 7 (Fig. 1).

On March 24, Tucker et al. (2018, ATel 11473) reported spectroscopic follow-up and a TDE candidate

[1] We internally nicknamed this source ZTF-NedStark.

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Photometric filtering looks promising

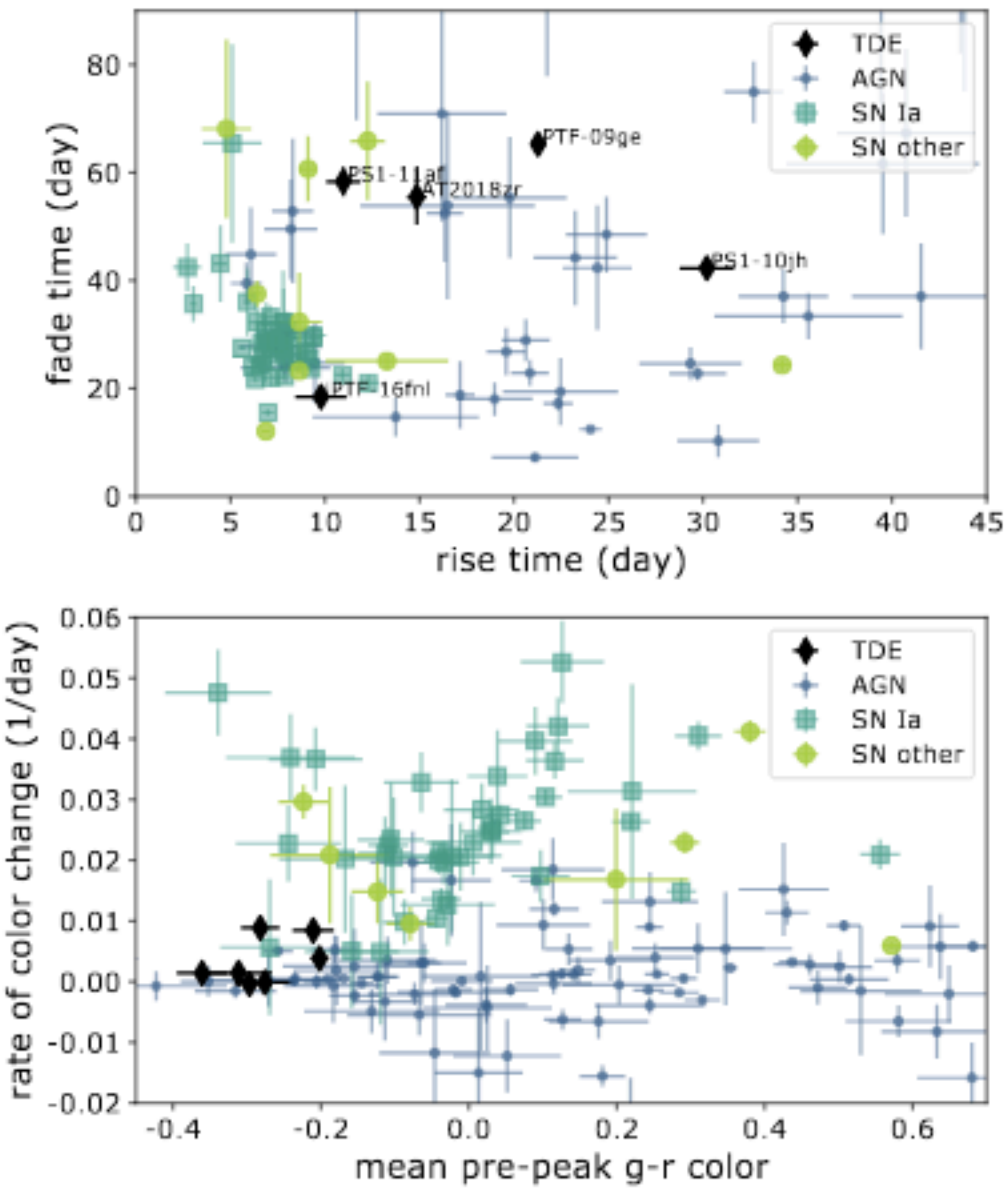

Figure 5. Tidal disruption flares compared to other nuclear flares and transients detected by ZTF. *Top:* Rise timescale versus the fade timescale, both measured using the g/r band observations, see Eq. 1

ZTF-NedStark now has plenty of friends (or enemies)

12 TDEs since last March, equal to entire pre-ZTF sample.

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ZTF+AMPEL have been a game-changer for TDE discovery




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Summary

- **TDEs are rare, and historically our selection efficiency has been poor.**
- We previously had only a handful of well-sampled lightcurves
- ZTF survey has changed the game. Such an efficient pipeline, including colour cuts, would not have been possible previously.
- ~100M alerts have been filtered to identify 12 spectroscopically-classified TDEs, most with excellent light curve coverage
- **TDE identification is moving from an art to a science! AMPEL has paved the way. Things look much more LSST-ready today.**