Another Funeral of Stars:
Tidal Disruption Events (TDE)

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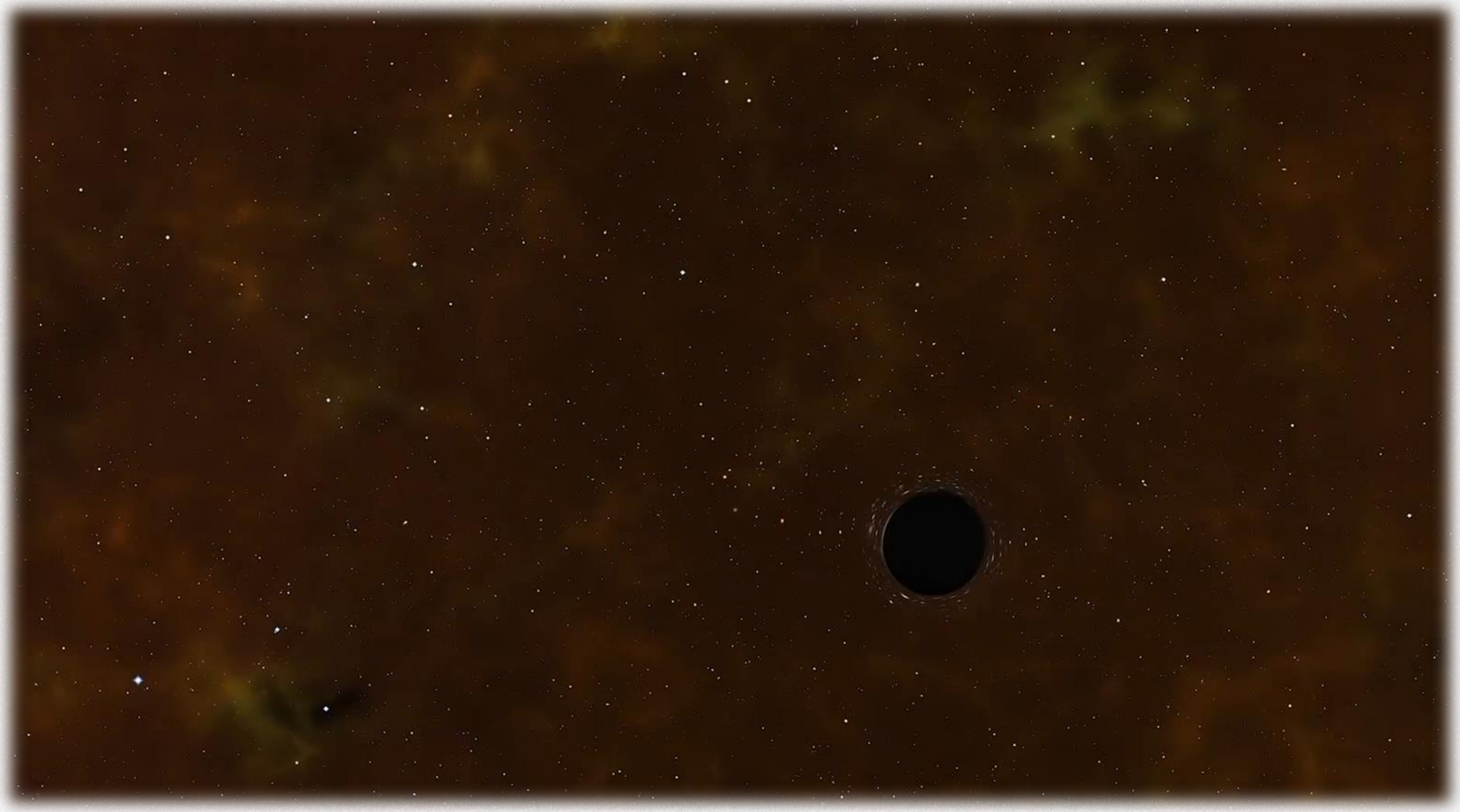
What is tidal disruption events (TDE)?



(NASA)

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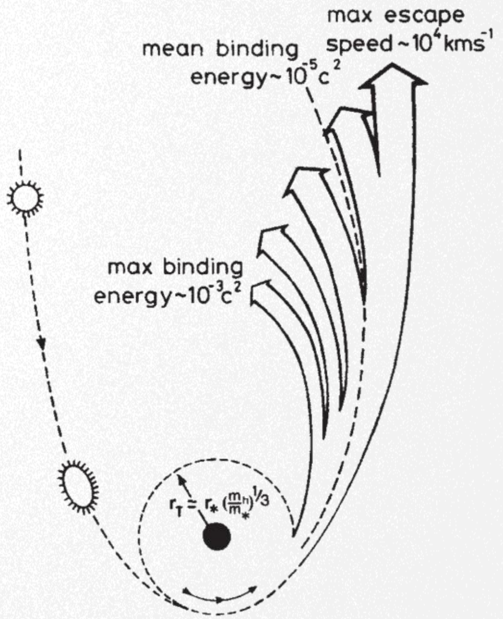
$$r_d \approx R_*(\frac{M_{BH}}{M_*})^{\frac{1}{3}}$$



(Rees 1988)

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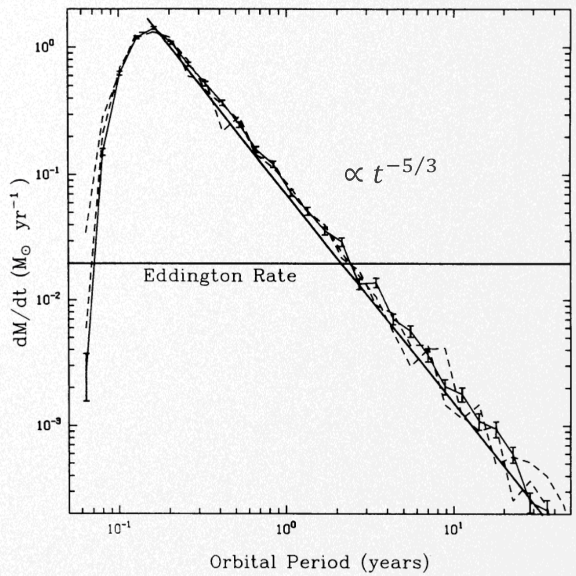
- Light curve follows (mass fallback rate):

$$\frac{dM}{dt} \approx \frac{1}{3}\frac{M_\odot}{T_\odot}\left(\frac{t}{T_\odot}\right)^{-5/3}$$



(Evans & Kochanek 1989)

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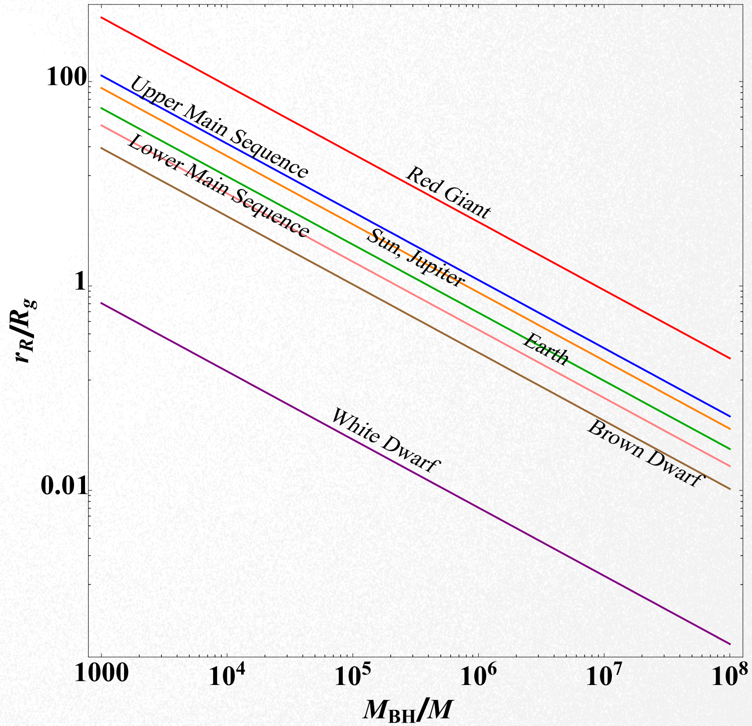
- The earliest X-ray observation is NGC 5905.
- 91 TDE candidates have been found by now.

Why we study TDE?

- Probe quiescent SMBHs, constrain M-σ relation.
- Test if IMBH exists ($r_d > 2r_g \iff M_{BH} < 10^7 M_\odot$)
- Provide a perfect environment to study accretion (and jet) physics due to the short time scale of the transient.
- Understand strong gravity around SMBHs.

Crucial physical properties (from theory)

- BH: mass, spin
- Disrupted star: mass, eccentricity, structure

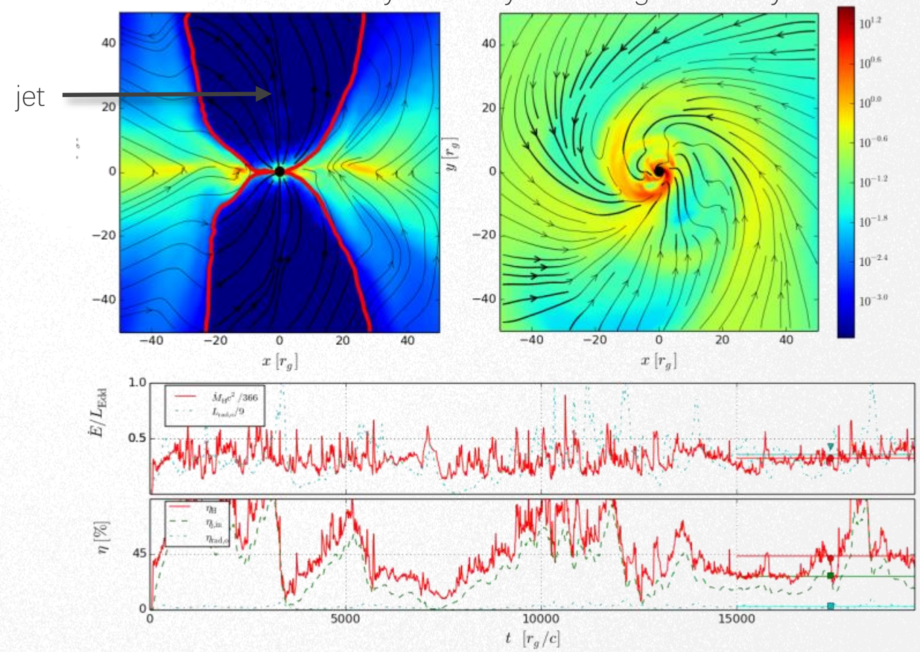


(Dai+ 2012)

Crucial physical properties (from theory)

- BH: mass, spin
- Disrupted star: mass, eccentricity, structure
- Physics of super-Eddington accretion

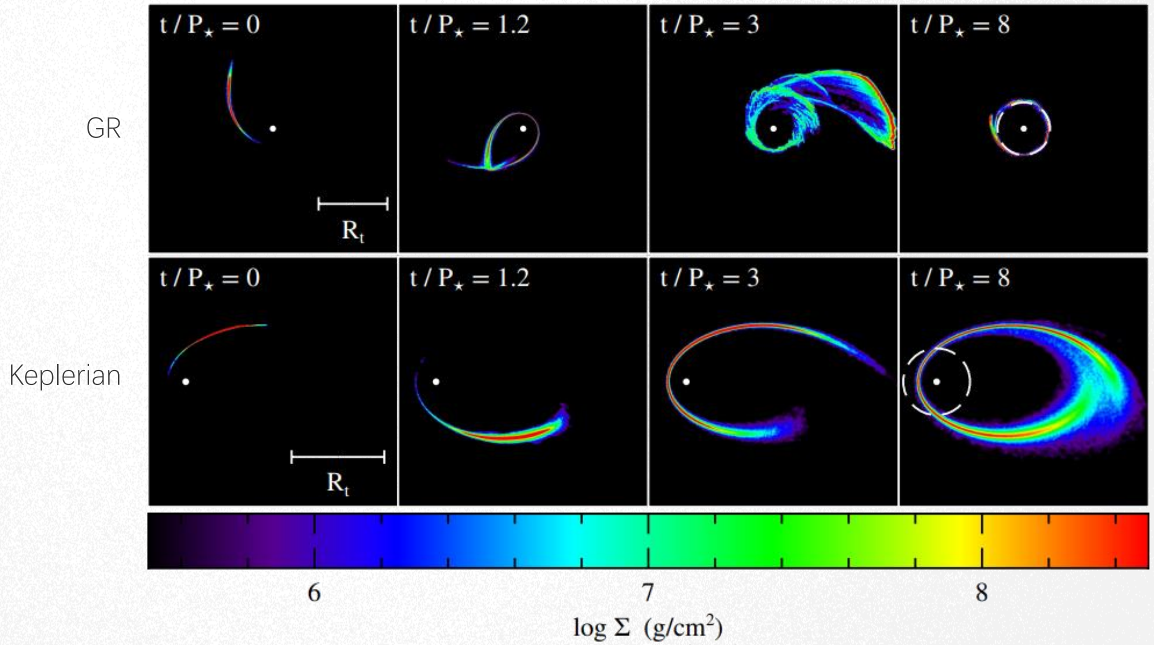
rest-mass density scaled by an Eddington density



(Dai+ 2018)

Crucial physical properties (from theory)

- BH: mass, spin
- Disrupted star: mass, eccentricity, structure
- Physics of super-Eddington accretion
- General relativity



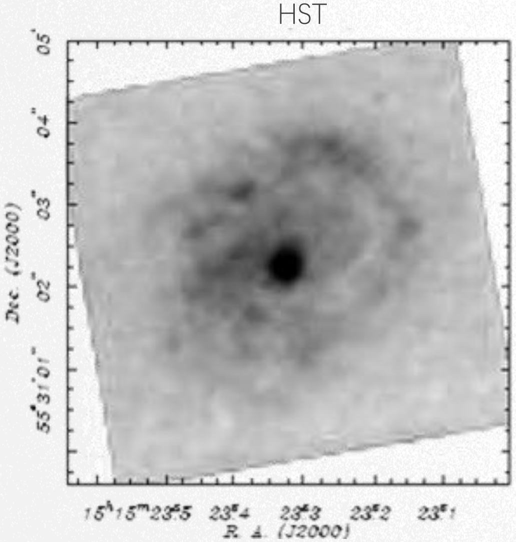
(Bonnerot+ 2015)

TDE candidates: NGC 5905

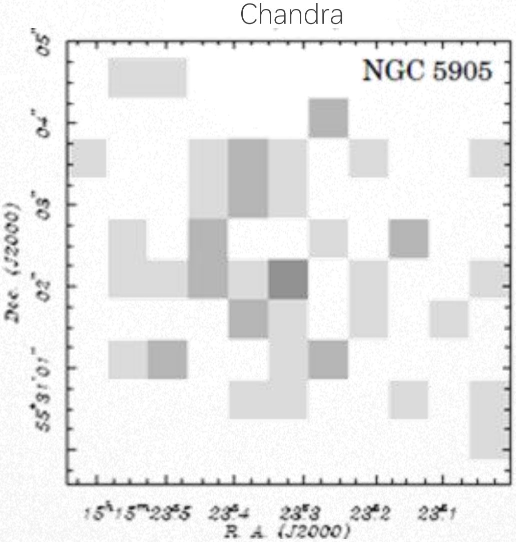
- First observed TDE candidate.
- z= 0.0113
- TDE? AGN ?

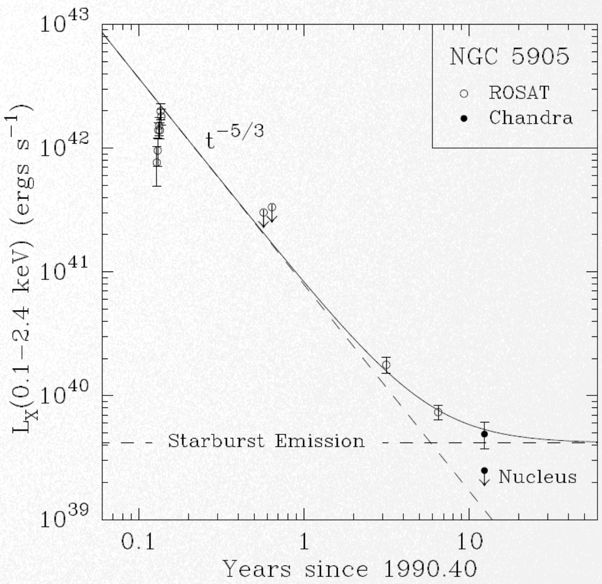
Date: 2002 Oct 4

HST



Chandra

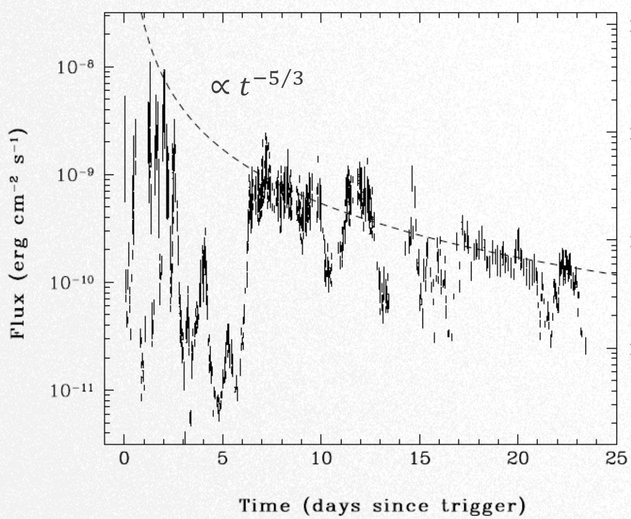




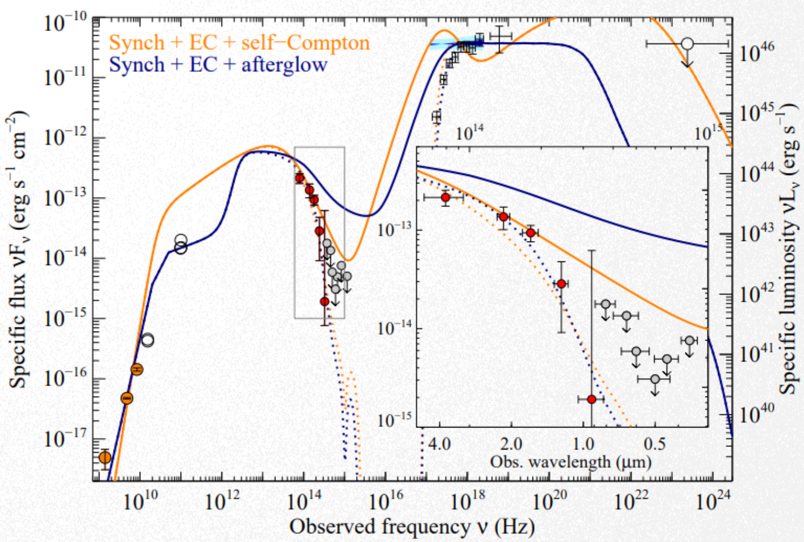
(Halpern,+ 2004)

TDE candidates: Swift J1644+57

- With jet (non-thermal component)
- z= 0.3543



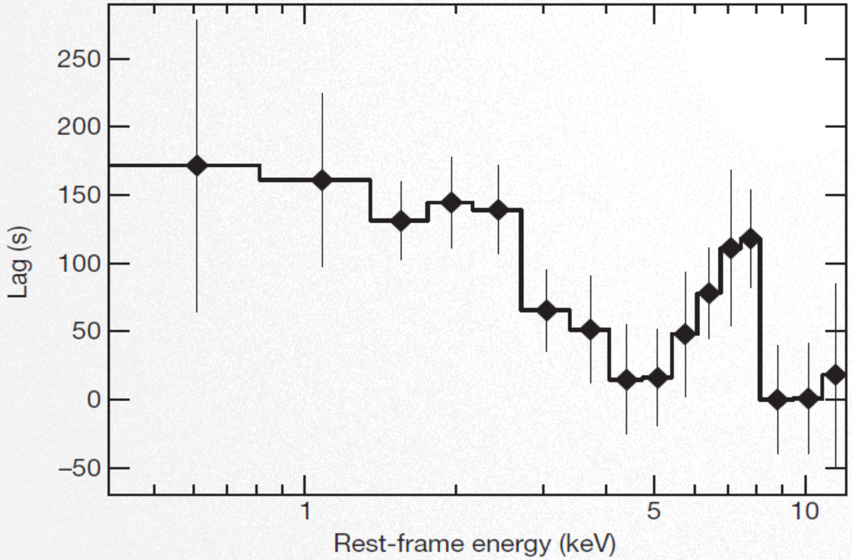
(Burrows+ 2011)

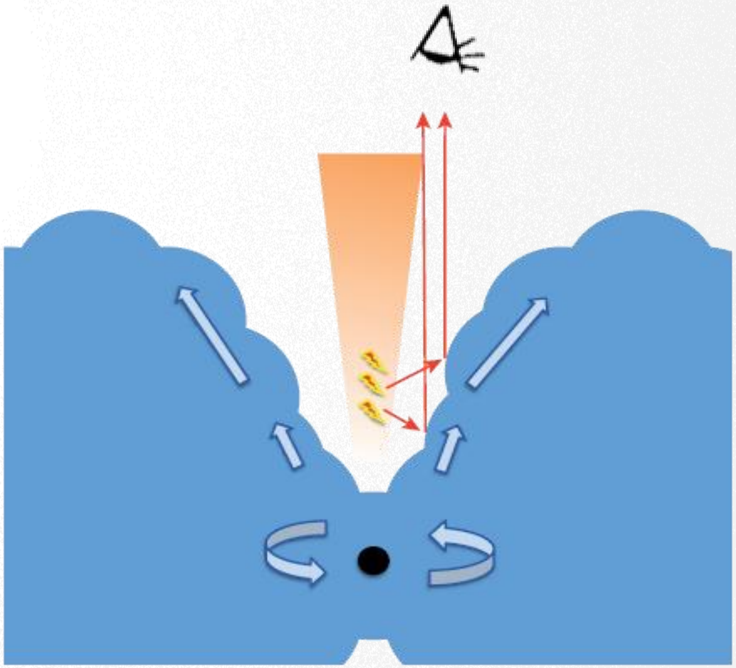


(Bloom+ 2011)

TDE candidates: Swift J1644+57

- With jet (non-thermal component)
- z= 0.3543
- M_{BH} about a few $10^6 M_\odot$



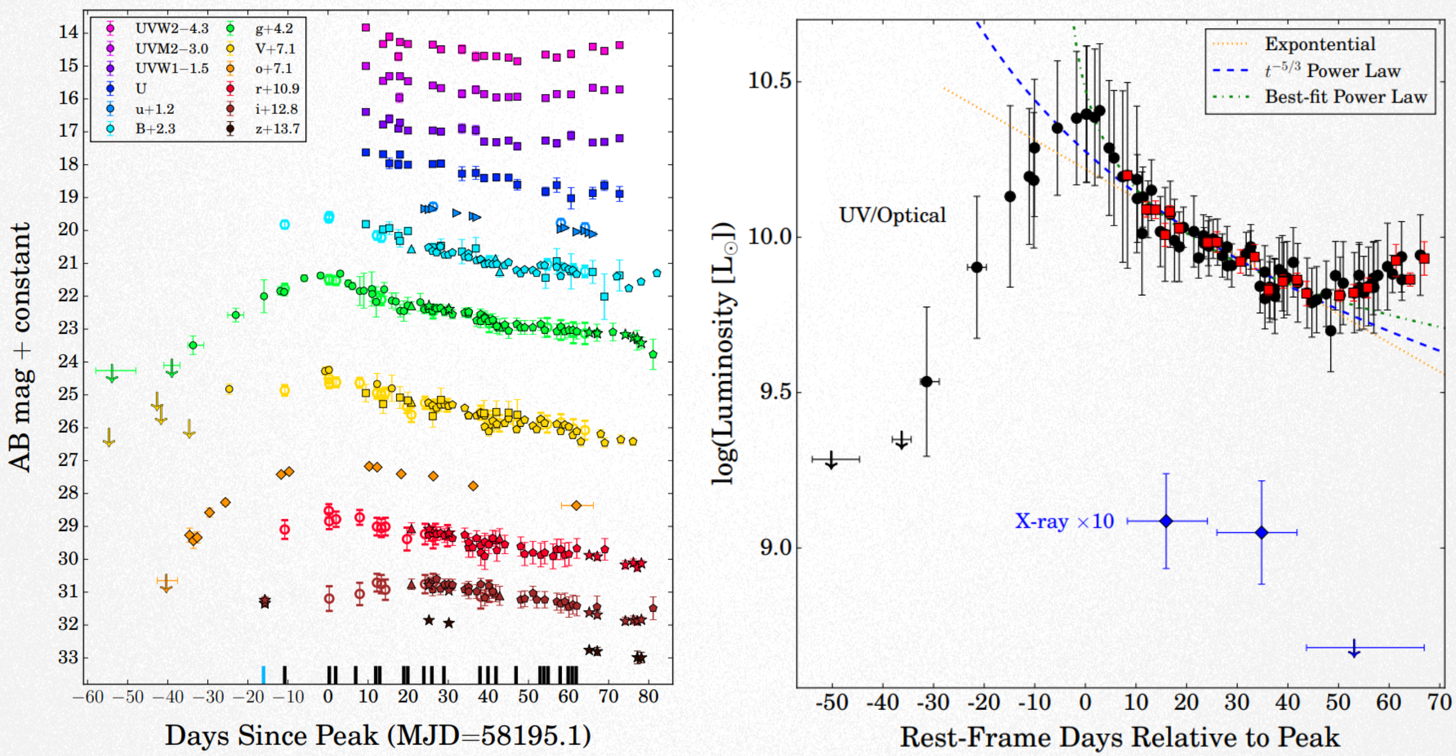


(Kara+ 2016)

Unique properties in observation

- The light curves usually peak and decay monotonically for months

PS18kh



(Holoien+ 2018)

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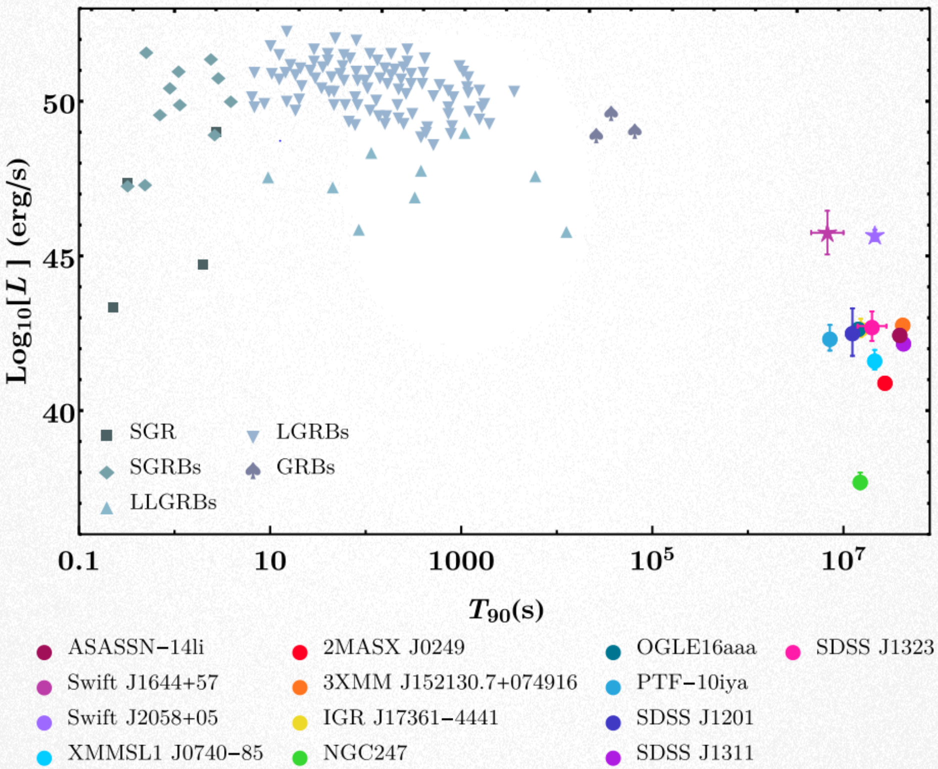
T_{90}: time interval in which between 5% and 95% of the total fluence



(Auchettl+ 2017)

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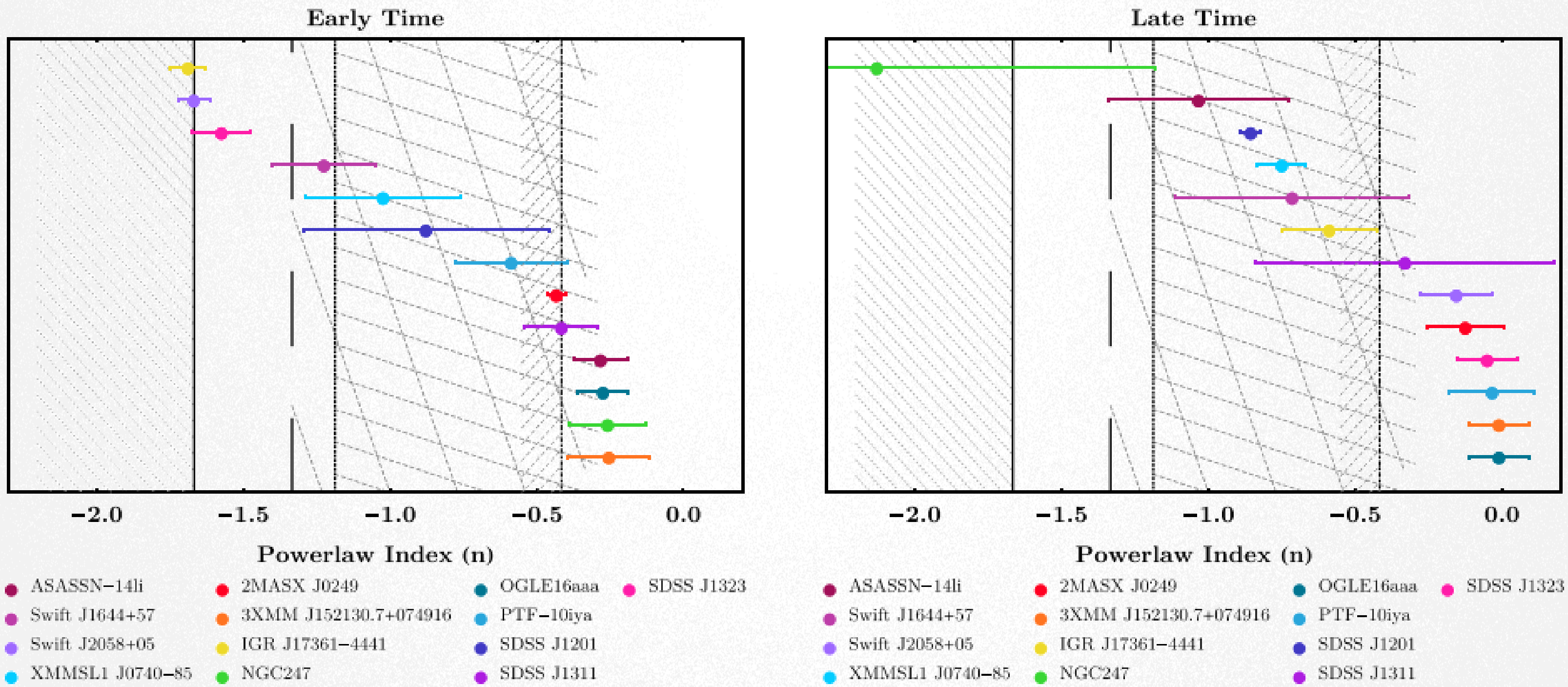
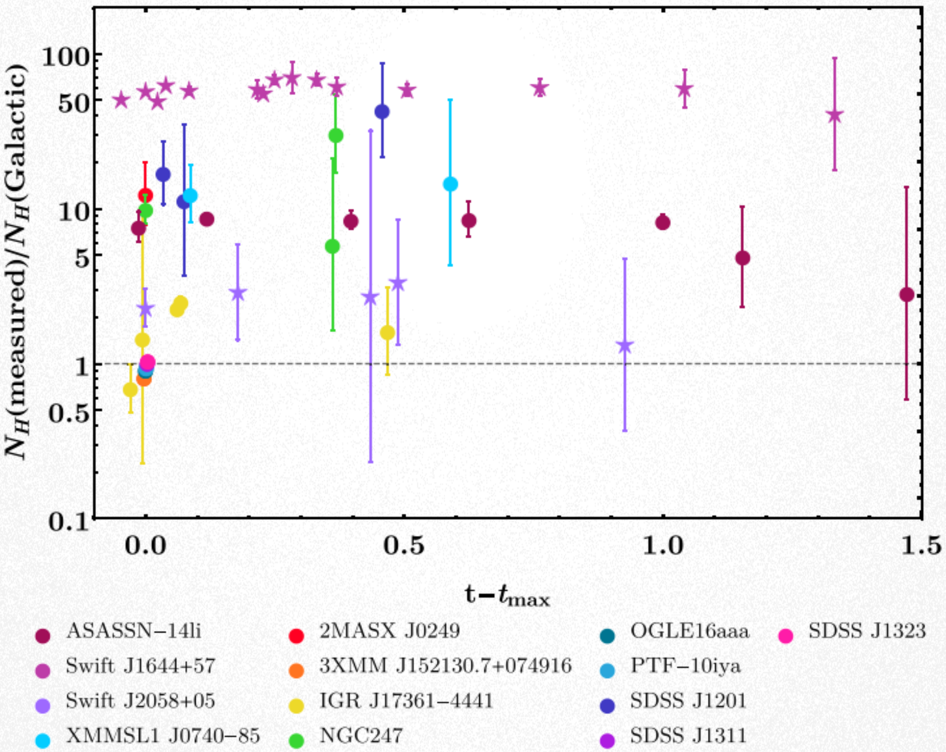


(Auchettl+ 2017)

Unique properties in observation

- No variation in column density N_H with time.



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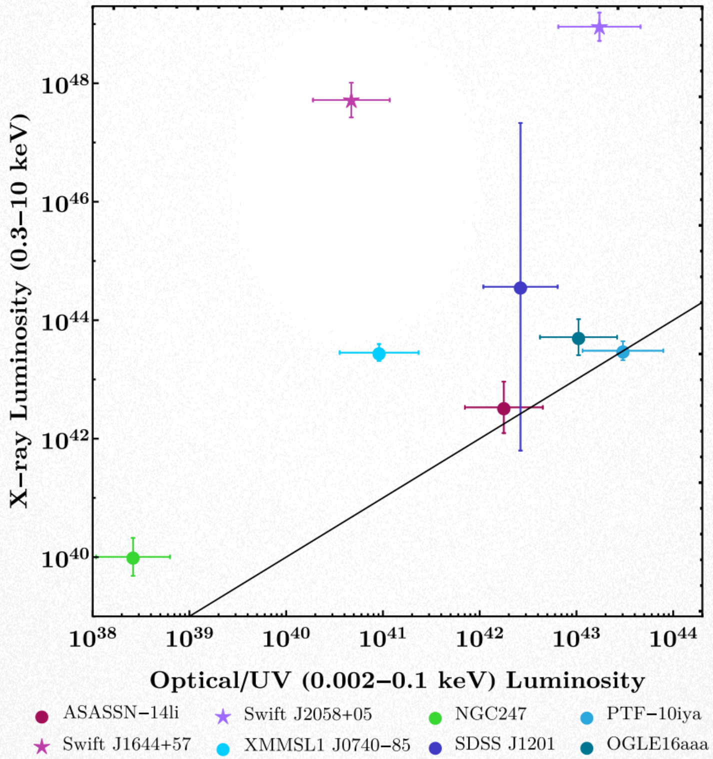
Unique properties in observation

- TDE candidates usually have intrinsically soft X-ray spectra with little variation in their hardness ratios as they fade.



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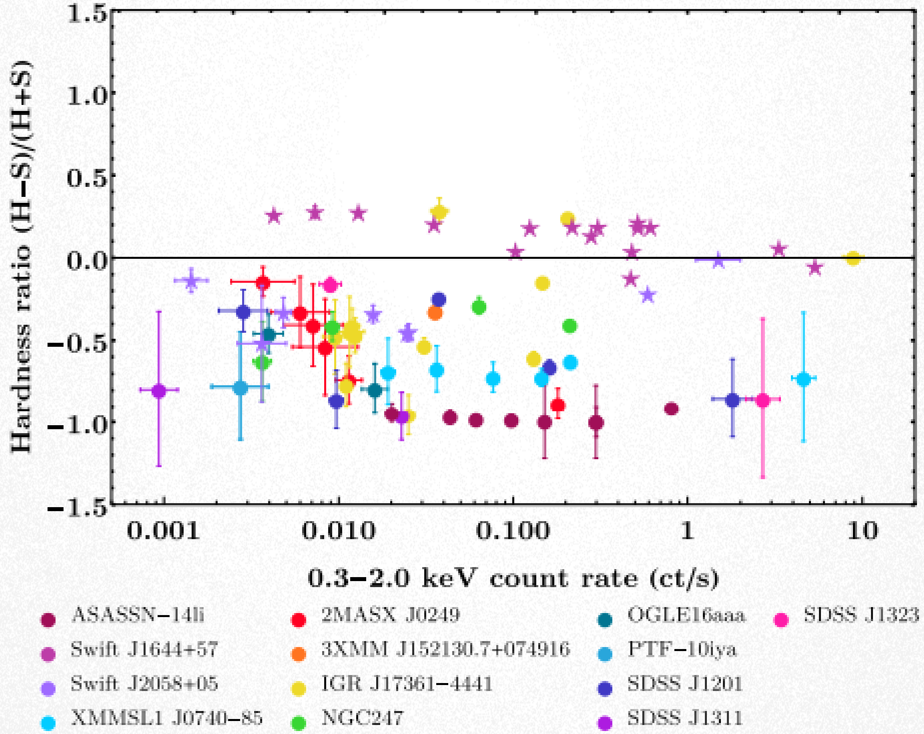


H: 2.0–10.0 keV

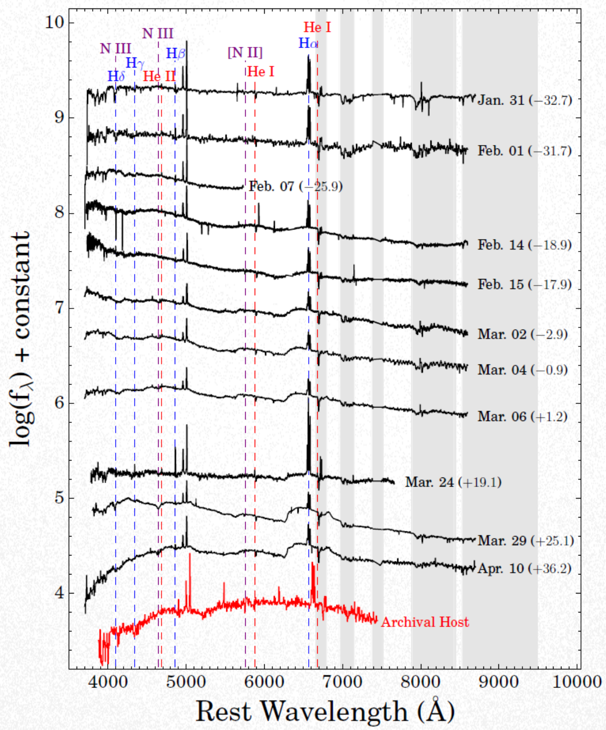
S: 0.3–2.0 keV

(Auchettl+ 2017)

Unique properties in observation

- The optical spectra are usually dominated by very broad (FWHM $\gtrsim 10^4\ km\ s^{-1}$) H and/or He II lines

ASASSN-19bt



(Holoien+ 2019)

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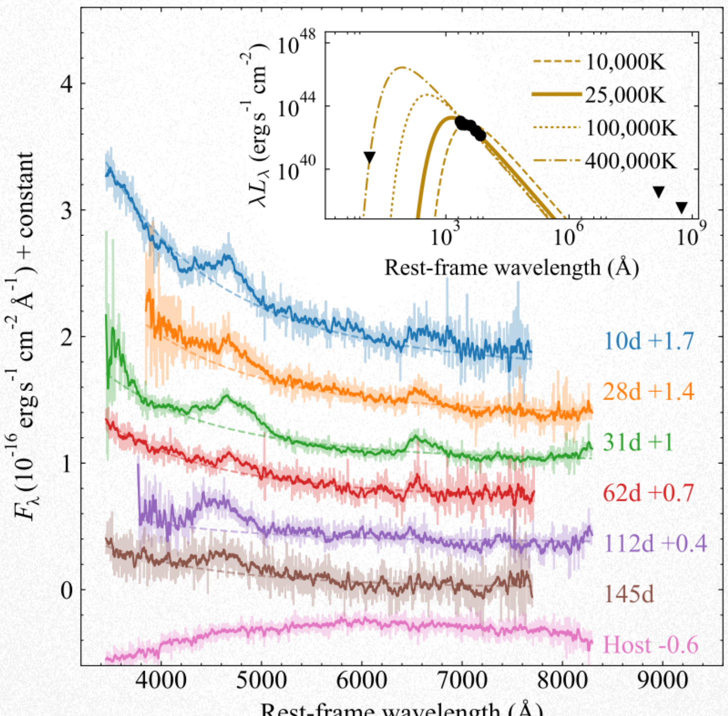
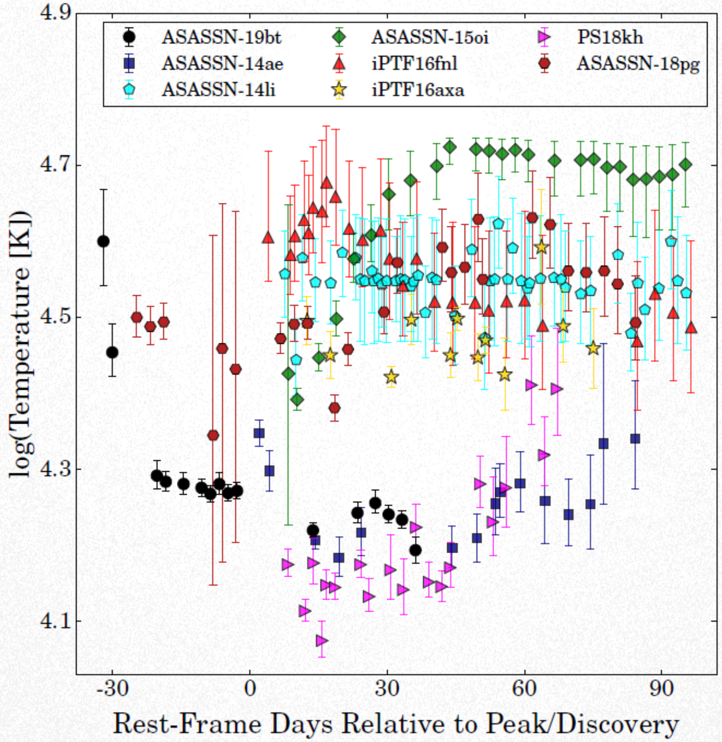
AT2017eqx



(Nicholl+ 2019)

Unique properties in observation

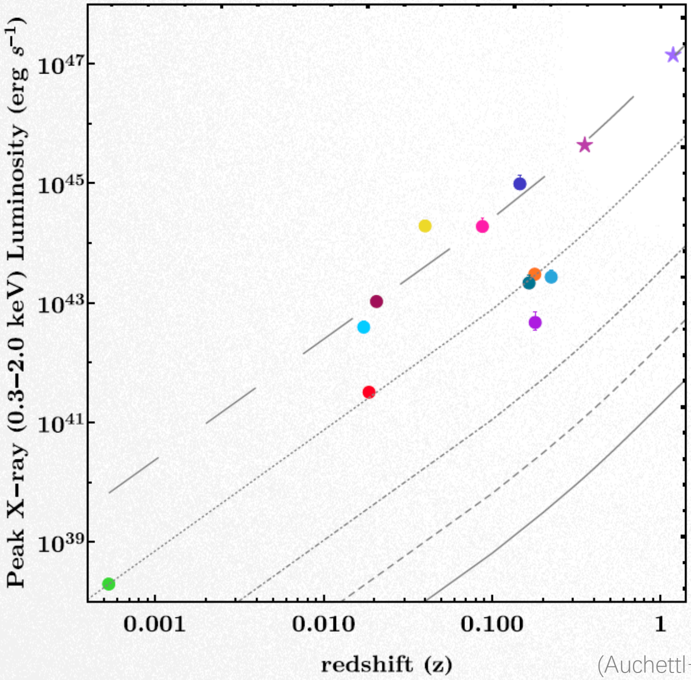
- The UV/optical SEDs are well modeled by blackbody with a few 10^4 K.



(Holoien+ 2019)

Summary

- A good environment to study the physics of super-Eddington accretion.
- More jobs need to be contributed, both theoretical and in observation: LSST, SKA, ZTF, eROSITA, Einstein Probe



Swift BAT 70 month 14–195 keV all-sky survey

ROSAT all-sky survey

Swift active galactic nucleus and cluster survey

XMM-Newton Lockmann 0.8 Ms survey

Chandra 2 Ms Deep-field North survey

(Auchettl+ 2017)

Citation

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