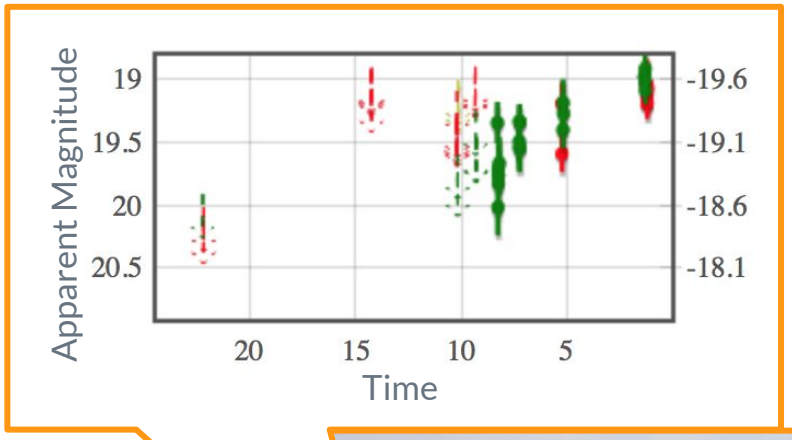
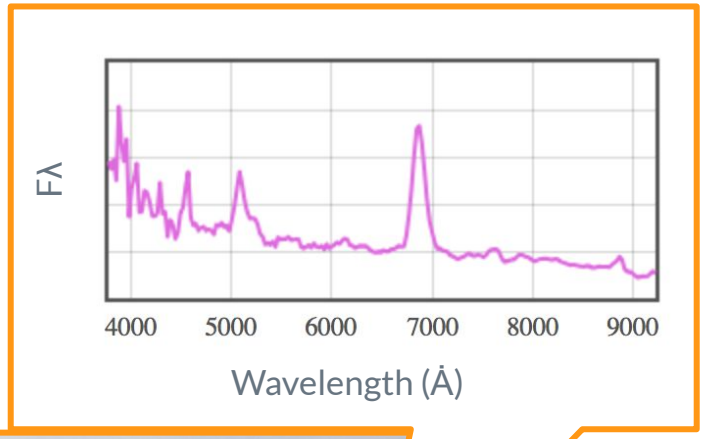
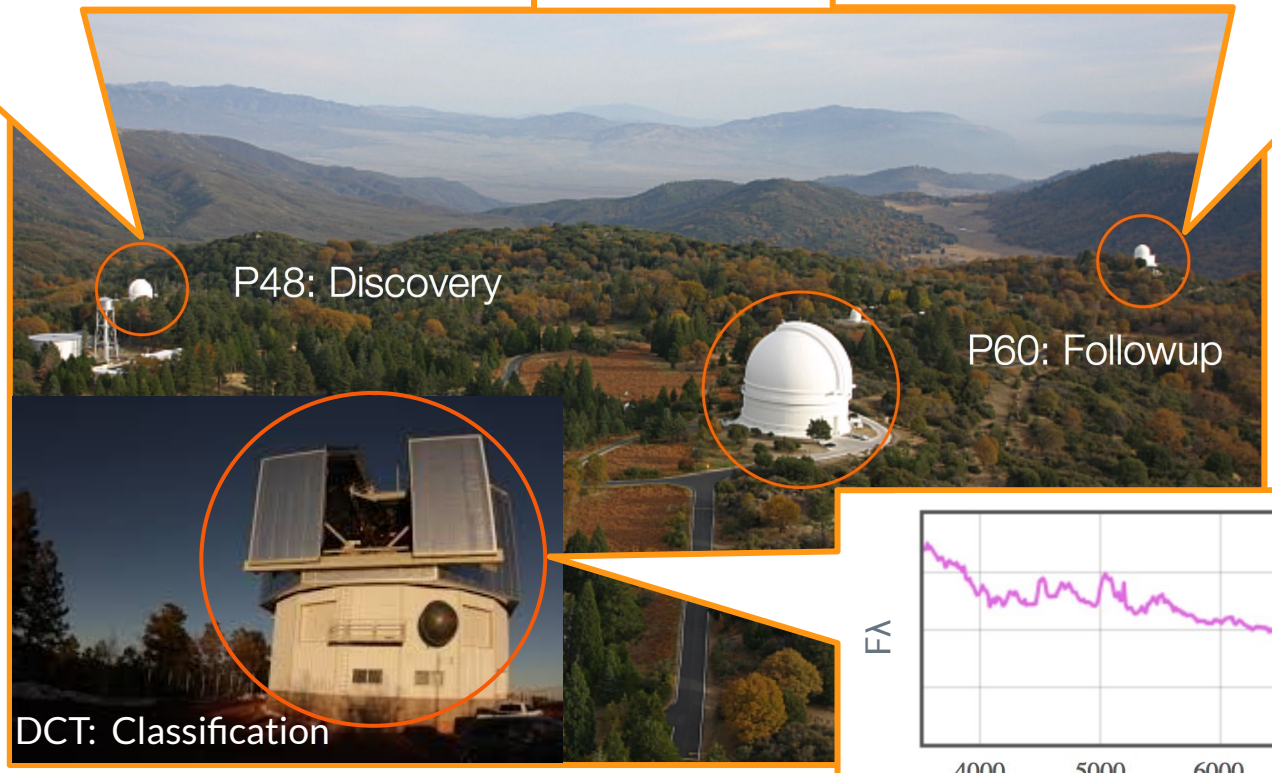
NASA/Swift/Aurore Simonnet, Sonoma State University

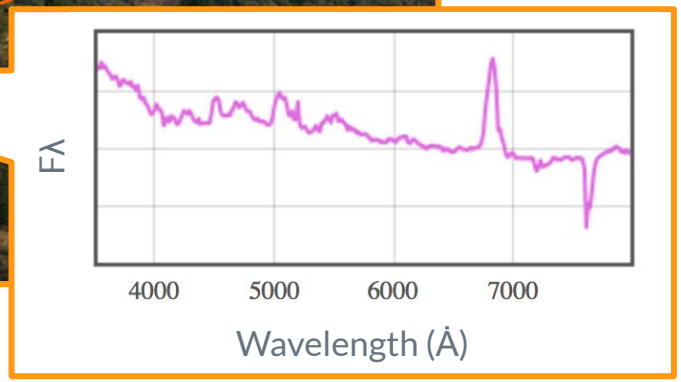
A New Class of Changing-Look LINERs Discovered in ZTF

Sara Frederick • QiC • Edinburgh • August 6, 2019





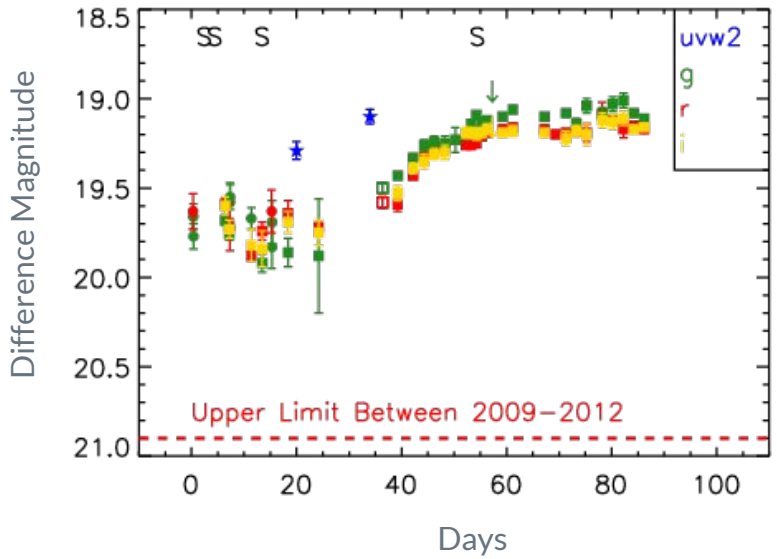




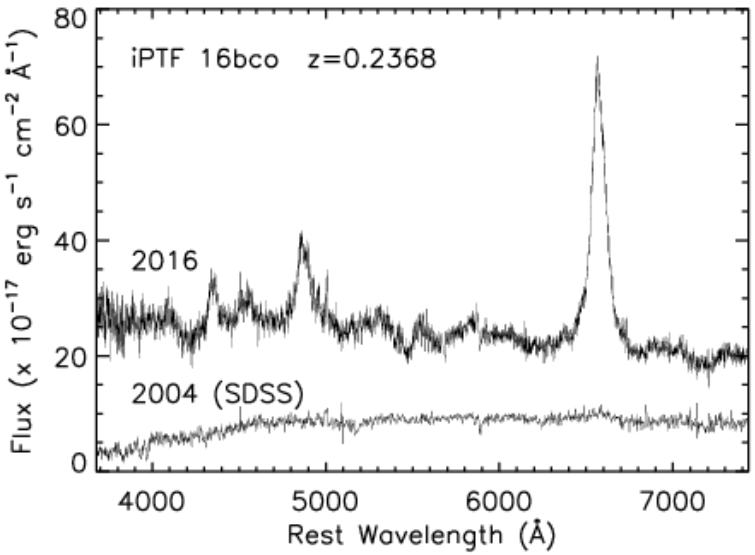
Zwicky Transient Facility

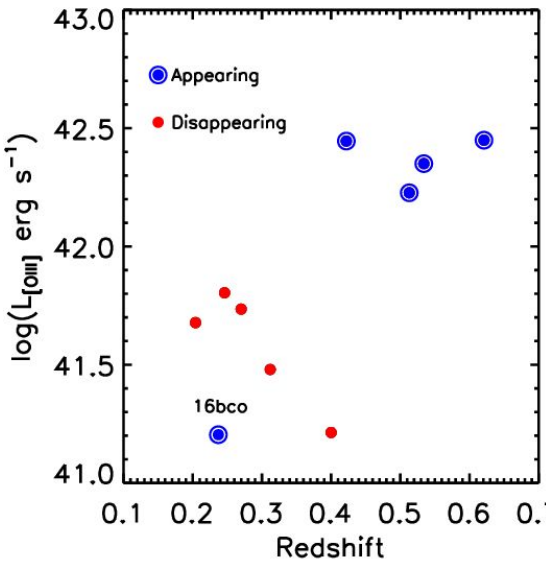
iPTF 16bco

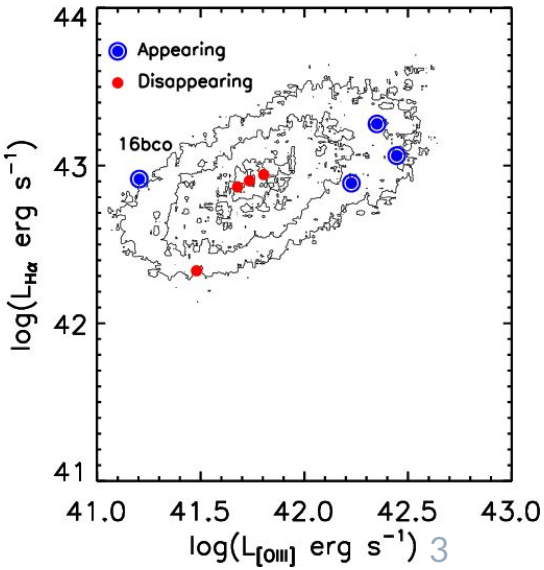
"iPTF Discovery of the Rapid "Turn-on" of a Luminous Quasar " [from a LINER] (Gezari+ 2017)



- Continuum increase x10, Enhanced Hα/[O III]
- Transition timescale < 1 year







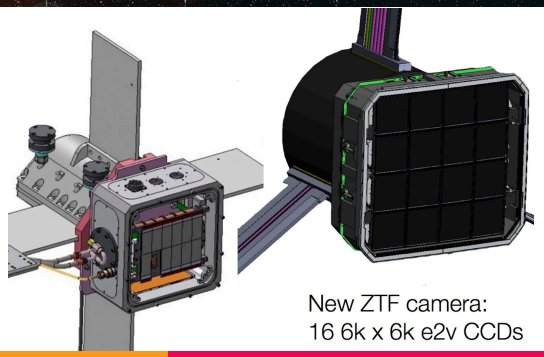
From iPTF to ZTF

Intermediate Palomar Transient Factory

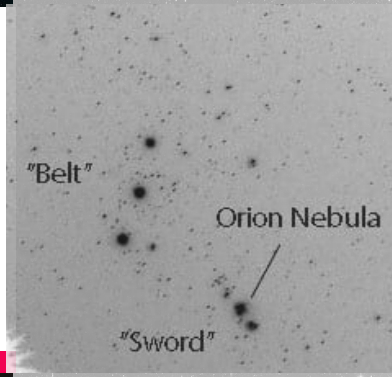
~7 deg^2 active area

ZTF's Giant Footprint

Camera Upgrade to Palomar 48"



New ZTF camera:
16 6k x 6k e2v CCDs



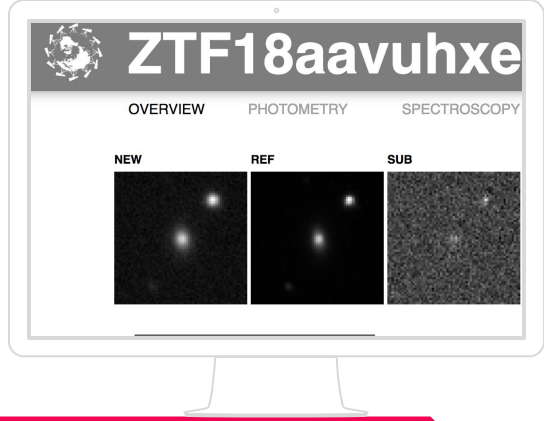
Zwicky Transient Facility

20.5 limiting r-band magnitude

47 deg^2 active area

→12x volumetric survey rate

A Systematic Search for Nuclear Transients "Turning on"

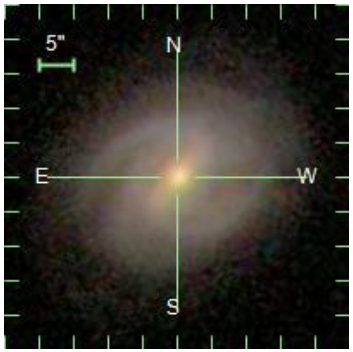


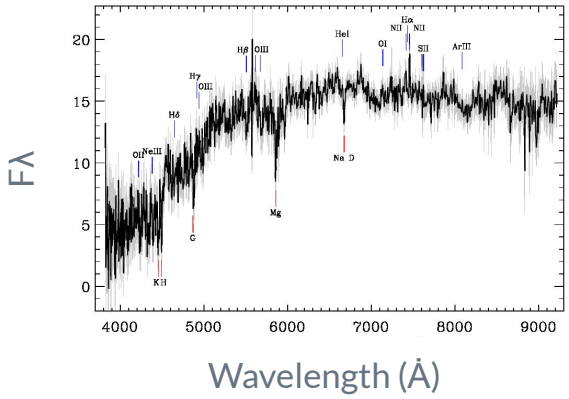
Nuclear (500/night) → Narrow/Galaxy → Variable

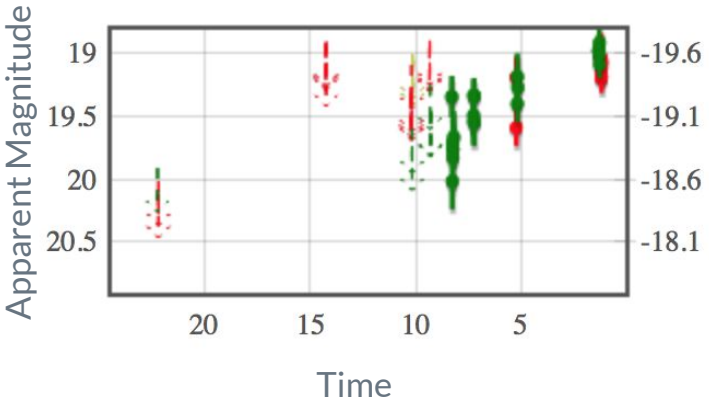
Transient offset from galaxy center within 0.5"

Matched within 1" of **LINER**/Sy 2/Composite galaxy (Portsmouth Emission Line Catalog; Thomas+ 2013)

Light curve shows real diff imaging detections and variability at ~0.1 mag level





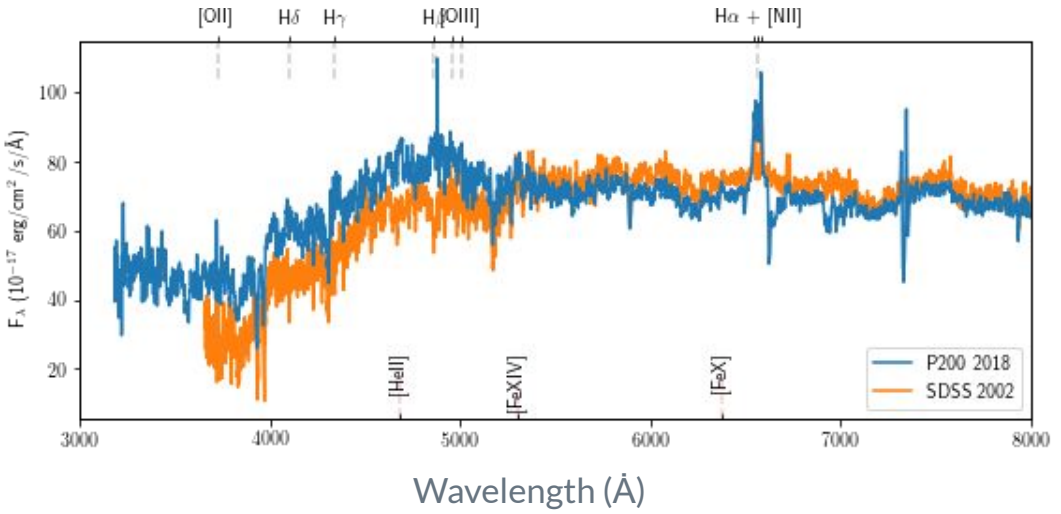


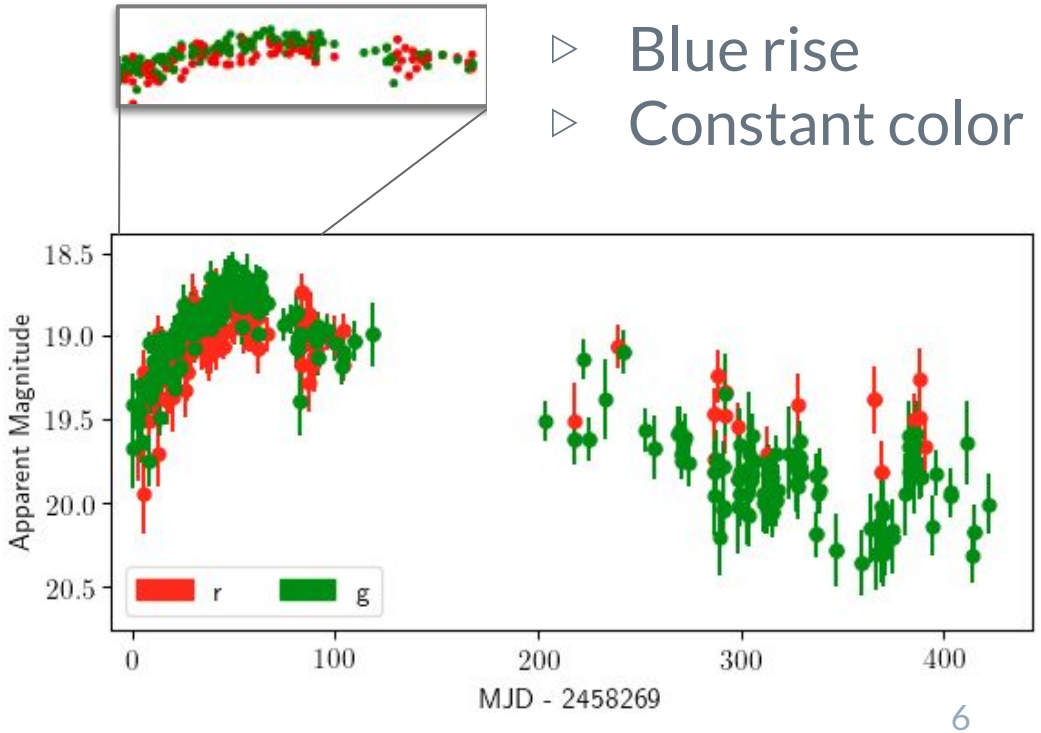
"Tyrion Lannister"

Blue in classification spectrum

- TDE or changing look AGN candidate?

2002 → 2018

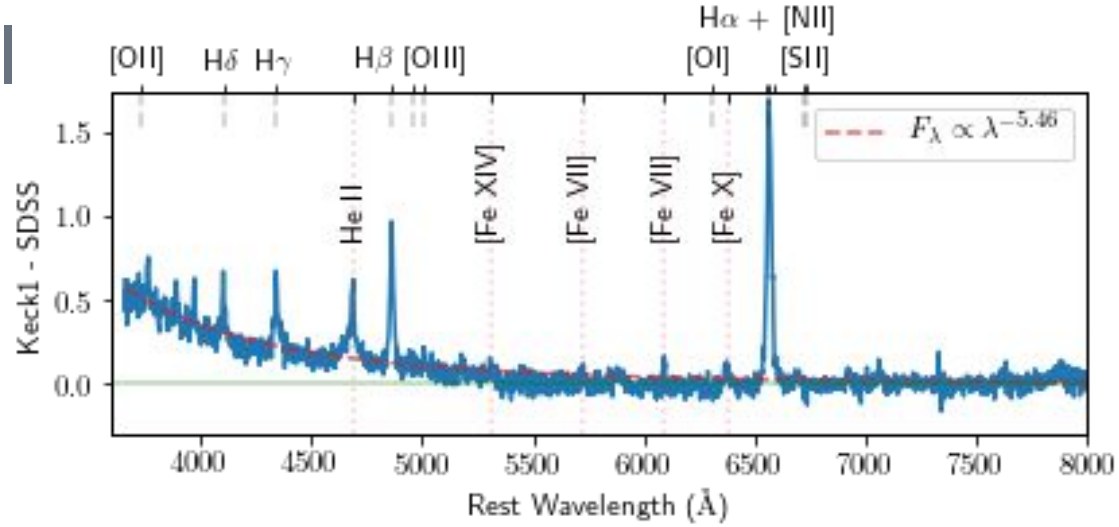




- Blue rise
- Constant color

Spectroscopic Follow up

- "Extreme" coronal lines
- Blue power law continuum
- "Narrow" Balmer lines
- Weak [O III]
- Balmer, He II luminosities inconsistent with TDEs



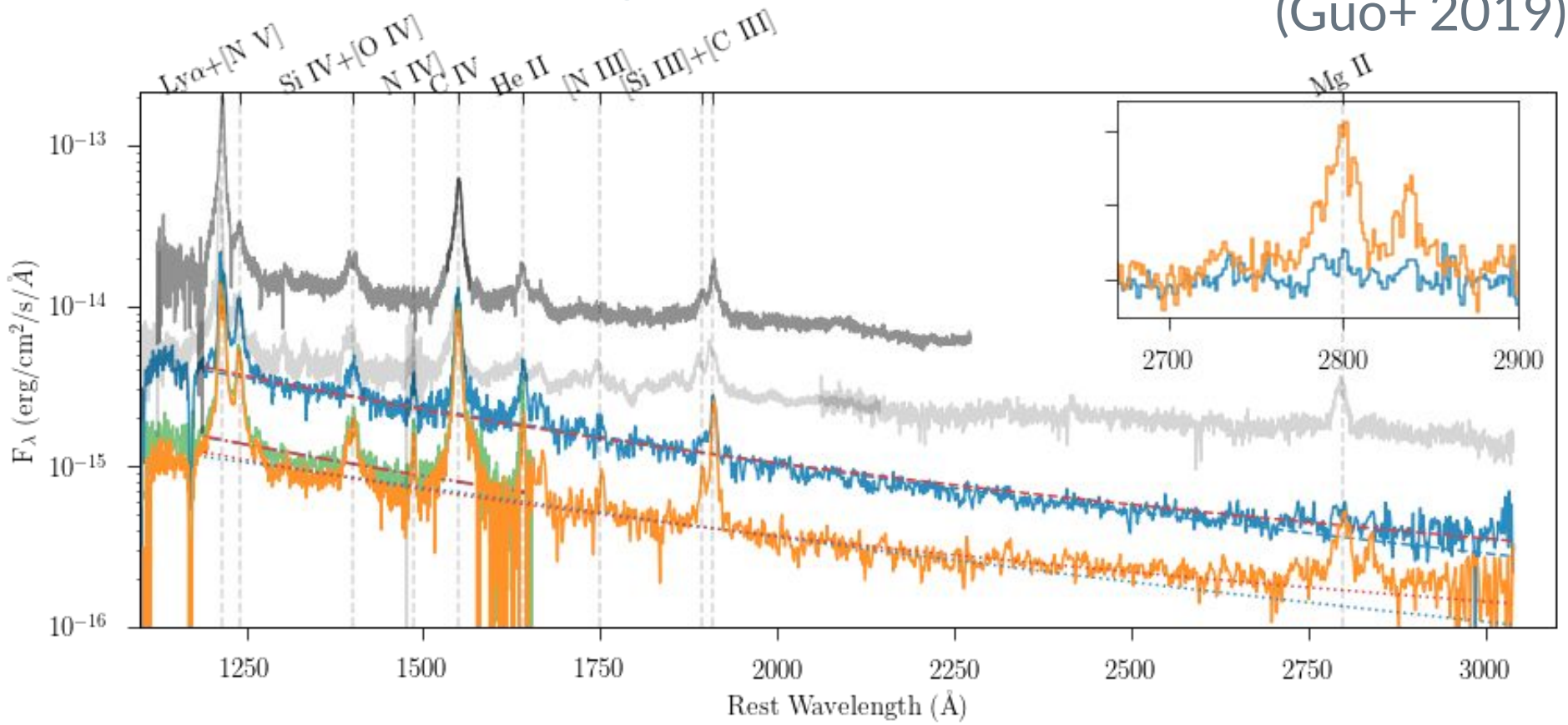
Frederick, Gezari, Graham, VanVelzen+ 2019

(arxiv: 1904.10973)

UV Spectroscopy

"Changing-Look Mg II AGN"

(Guo+ 2019)

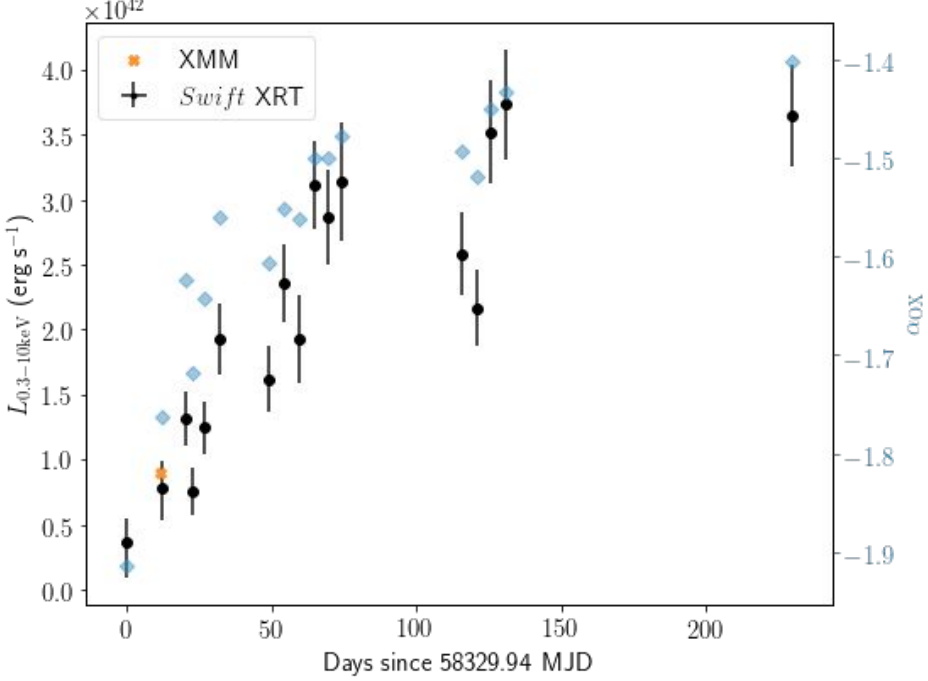


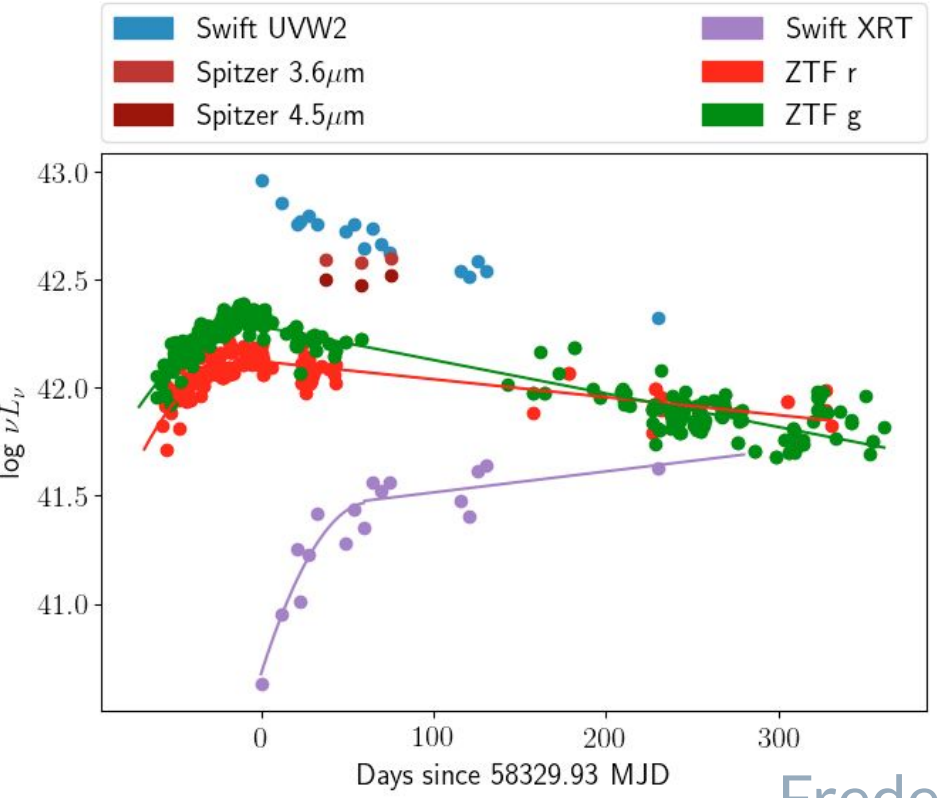
Frederick+ 2019

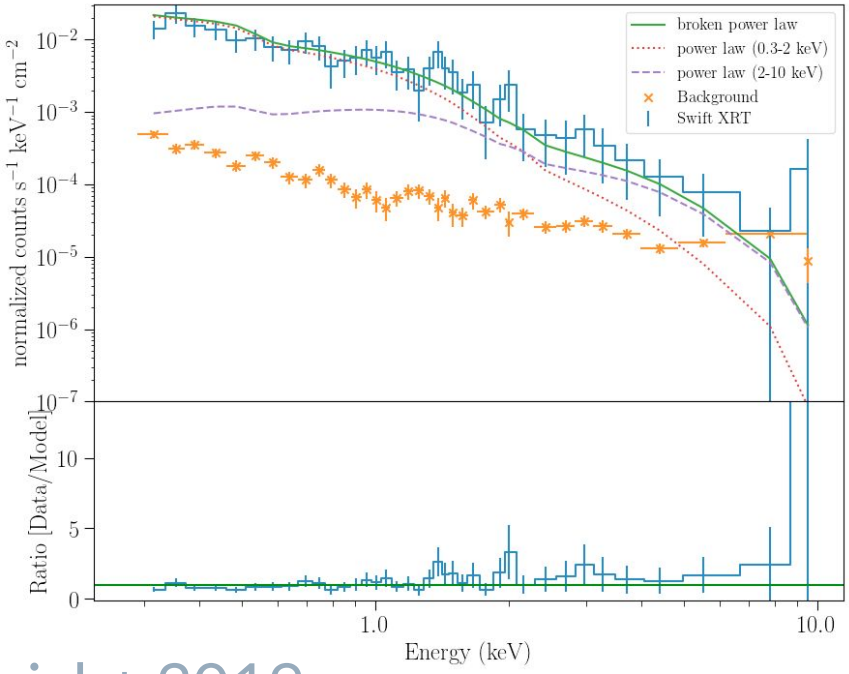
- UV coronal lines, stronger Mg II, C IV/[C III]

X-ray Follow up

- Soft X-ray flare delayed by 2 months







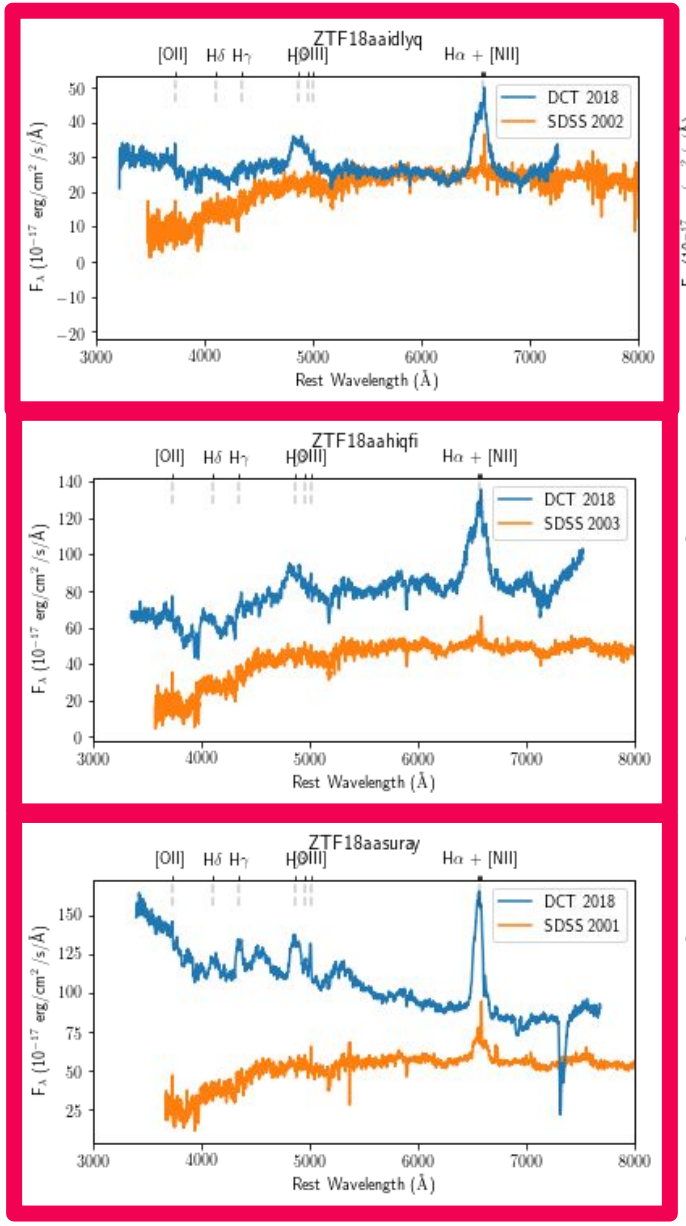
Frederick+ 2019

Events host-dependent?

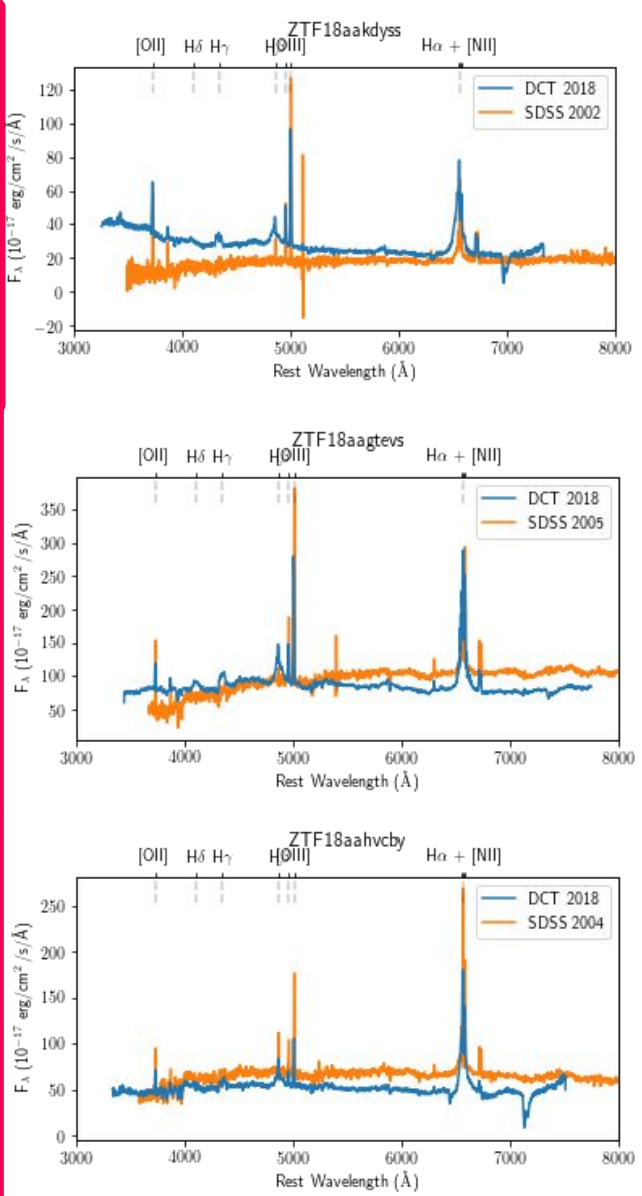
Changing look AGN sample from first year of ZTF survey →

- LINERs in “off” state showed dramatic spectral variability

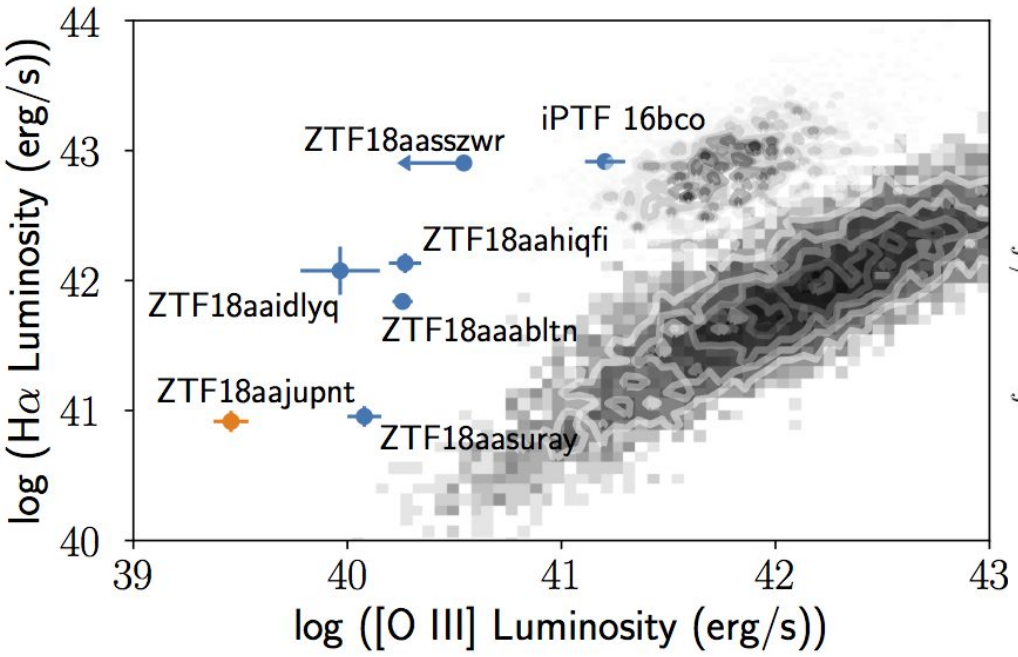
LINERs (“type 3”)

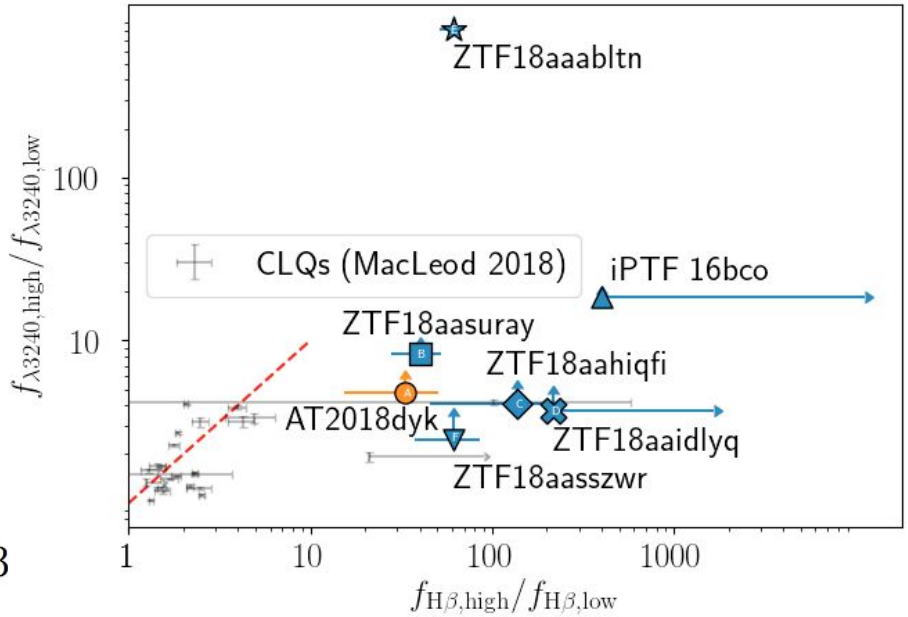


Seyferts 2 → 1



Comparisons to (CL)AGN





- Enhanced Hα/[O III]
- Dramatic continuum/broad line flux changes

Elitzur+ 2014 Evolutionary Sequence

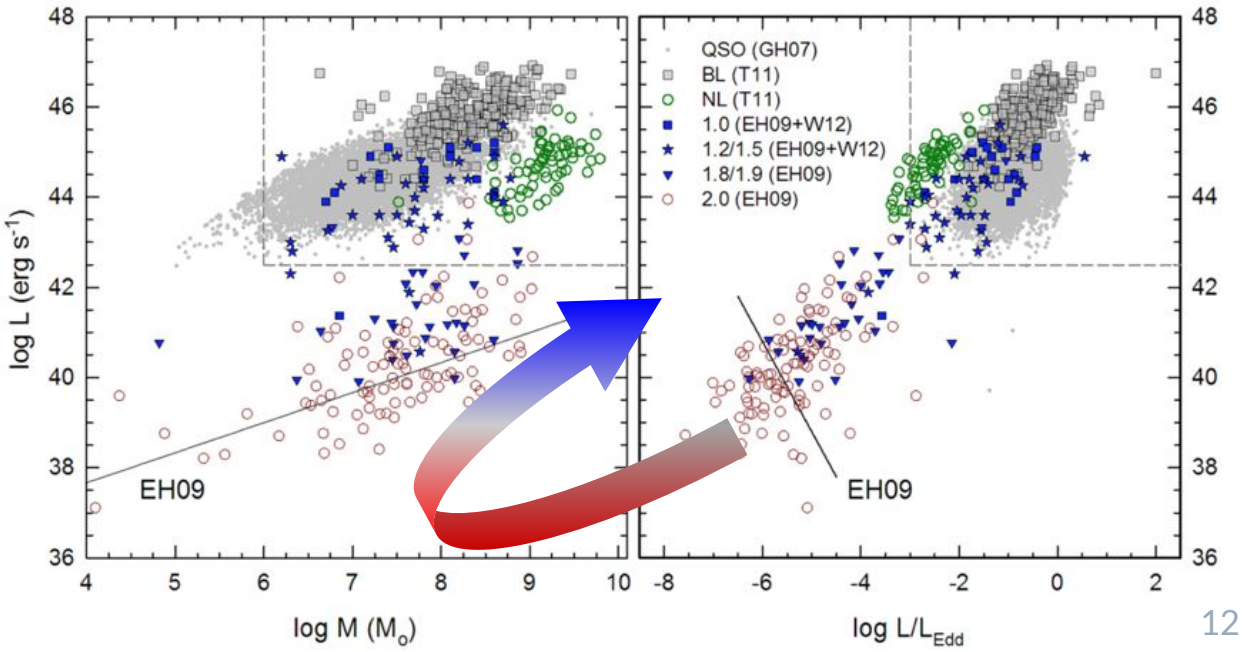
- Disk Wind Scenario Predicts Evolutionary Sequence: type 2 → intermediate type (1.2-1.5) → type 1 (Nicastro 2000, Elitzur+ 2014)

Quasars

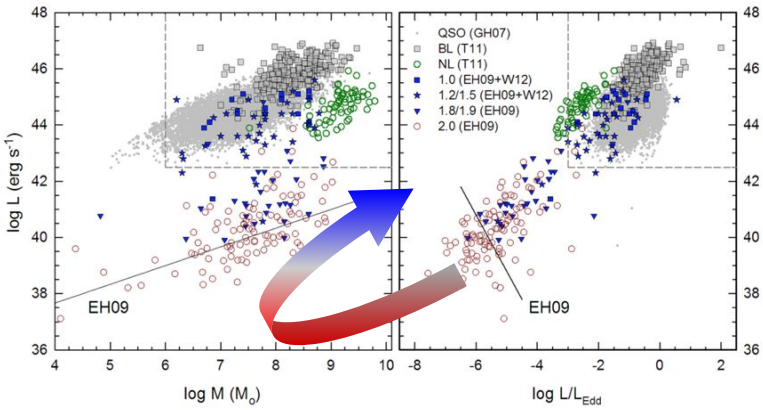
Seyfert Type 1

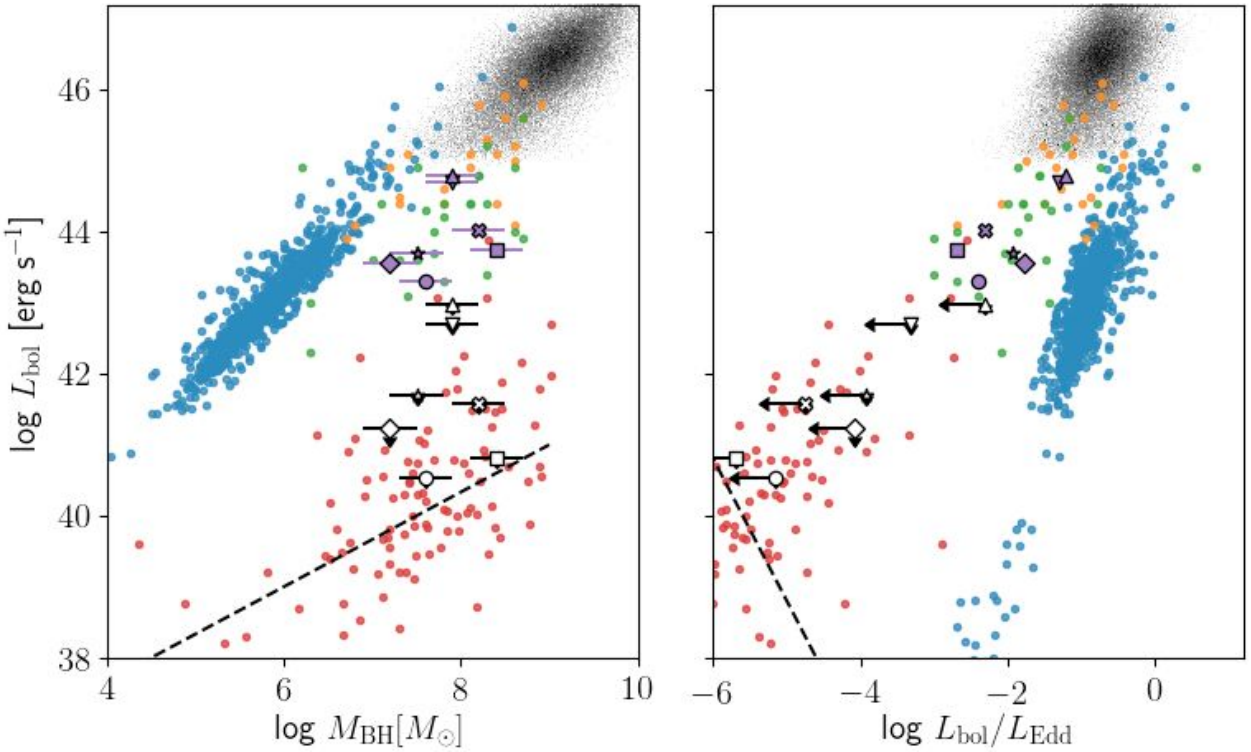
Intermediate Type

Seyfert Type 2



Elitzur+ 2014 Evolutionary Sequence

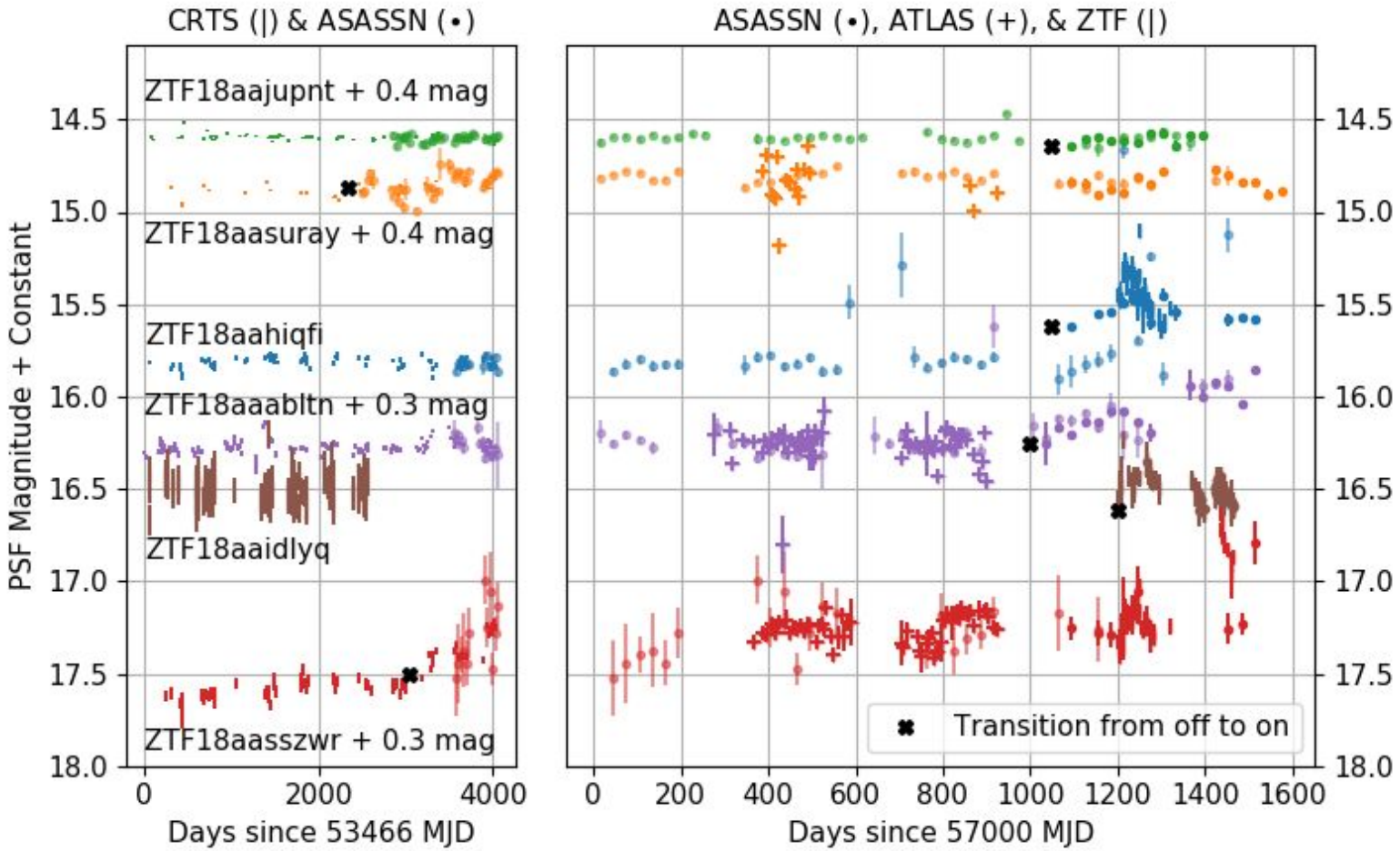




Quasars (Shen et al. 2011)
NLS1s (Mullaney et al. 2013)
Type 1s (Winter et al. 2012)
Type 1.2/1.5 (Winter et al. 2012)
Type 2s (Ho 2009)
(A) ZTF18aajupnt (AT2018dyk)
(B) ZTF18aasuray
(C) ZTF18aahiqfi
(D) ZTF18aaidlyq
(E) ZTF18aaabltn
(F) ZTF18aasszwr
iPTF 16bco

Archival Light Curves

2005-2013 2018



- All exhibit similar slow flare behavior, Tyrion was fastest
- Can constrain transition timescales, event rate ~4 year^{-1}

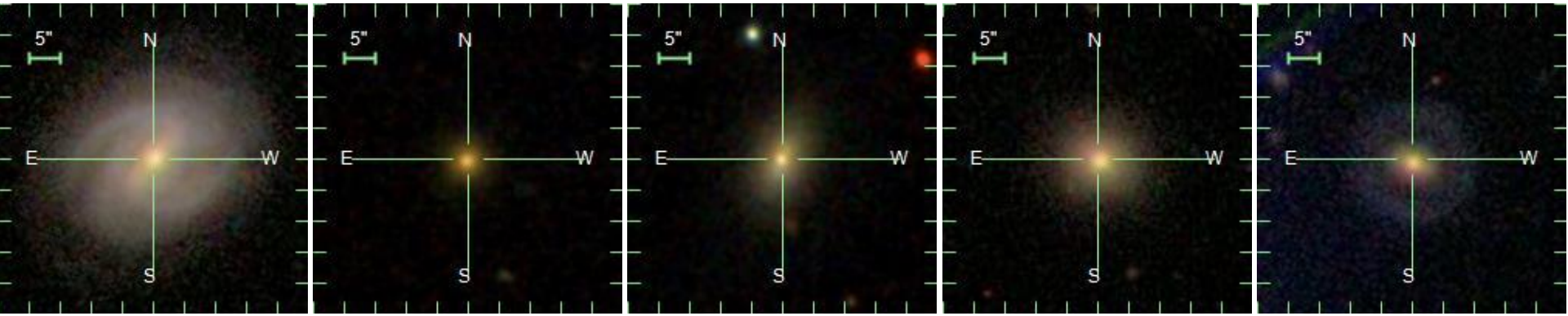
Open Questions

- **What excites CL LINERs?**

  Weak, dwarf, or low-luminosity Seyferts?

- **What are their environments?**

  Accretion flows in “on” and “off” states?



Summary

- ZTF enabled a systematic search for CLAGN in real-time
- New class of changing look LINERs (8 total)
- “Tyrion” underwent multiwavelength follow-up campaign, first reported CL LINER→NLS1